MANUAL FOR APPROVAL (Rev. 2)

10/29/14

Environmental Technical Sales, Inc.
7731 Office Park Blvd.
Baton Rouge, LA 70809
Phone: (225) 295-1200
Attention: Ms. Kathryn Terito

RE: City of Bossier City
Red River WWTP Exp & Rehab
NE WWTP Upgrade & Rehab Project 10-DQ-06, 10-BI-04, & 10-DQ-07
Bossier City, LA
Evoqua Order No.: 2033/000140 (44792)
Oxidation Ditch Smart BNR™ System -Submittal Number M-11330-002-A

Per the specification for the O&M Manuals, (1) copy of the O&M manual in electronic format (PDF) is attached.

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PLEASE ENDEAVOR TO REVIEW THESE MANUALS WITHIN THE NEXT THREE WEEKS SO THAT FINAL MANUALS MAY BE SUBMITTED.

Please contact your **Evoqua** Project Manager Robert Spuhler with your approval at the address /phone numbers on this letter.

If your approval is conditional, **please be specific in your request for changes** to this submittal and include reference to the appropriate section of the specification where these requirements are outlined.

CC: File
Project Manager: Robert Spuhler

Evoqua
Water Technologies
2607 N. Grandview Blvd., Suite 130 Telephone 262-547-0141
Waukesha, WI 53188 Facsimile 262-547-4120

Service Manuals

Order No.: 2033/000140 (44792)

Customer P.O.

Installation

City of Bossier City

Red River WWTP Exp & Rehab

NE WWTP Upgrade & Rehab Project

Bossier City, LA

Mailing Address

Environmental Technical Sales, Inc.

7731 Office Park Blvd.

Baton Rouge, LA 70809

Phone: (225) 295-1200

Attention: Ms. Kathryn Terito

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Max Foote Construction Company
225 Antibes West
Mandeville, LA 70448
Phone: (985) 624-8569/Fax: (985) 624-8580

Quantity: One (1) Electronic Copy for Approval Rev.1

Equipment

P.02: Smart BNR System

Mailed

10/29/14

For Service and/or Parts Please Contact The Sales Rep. Below:

Ms. Kathryn Terito
Environmental Technical Sales, Inc.
7731 Office Park Blvd.
Baton Rouge, LA 70809
Phone: (225) 295-1200

cc:
File
Project Manager: Robert Spuhler
Field Service

This is an uncontrolled copy of the manual. By receiving this copy of the manual, you agree that any modifications, deletions or insertions that you make to the information contained in it may cause your warranty with Evoqua to be null and void. In addition, you agree to indemnify, defend and hold Evoqua harmless from all claims for injury and damages caused by any such modifications, deletions or insertion.

City of Bossier City
Red River WWTP Exp & Rehab
NE WWTP Upgrade & Rehab Project
Volume 1 OF 1

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Bossier City, LA – 2033/000140 (44792)
SmartBNR™ Process
October 8th, 2014

Sequence of Operation

I. Overview

Evoqua Water Technologies SmartBNR™ Process and related components are controlled through one central programmable logic controller (PLC) and operator interface terminal (OIT). The OIT will be the primary interface that allows the user to interact with the various components, change process set points and monitor current readings of various sensors and probes located throughout the system.

The Smart BNR™ system is designed to enhance energy efficiency of the oxygen delivery to the wastewater while achieving a high quality effluent. Oxidation Reduction Potential (ORP) is measured in the first & second ditch, and dissolved oxygen (D.O.) is measured in all three oxidation ditches. The required oxygen is delivered by automatically controlling the speed and number of aerators running.

II. Hardware

a. Instrumentation & Sensors

The individual sensors listed below are connected to analyzers located nearby the equipment. The instrument analyzers are Hach model sc200, in NEMA 4X rated enclosures. They require 120VAC, single phase power and generate 4-20mA outputs to transmit back to the main control system, two (2) total analyzers are provided.

1. Two (2) Hach ORP sensors, Model DRS5, are provided. One probe is located in outer orbal channel and the other is located in the middle orbal channel. The ORP will be measured in a range from -2100mV to +2100mV.
2. Two (2) Hach Dissolved Oxygen sensors, Model LDO, is provided. One probe is located in the middle orbal channel and the other is located in the inner orbal channel. The DO will be measured from 0.0 to 20.0mg/L.

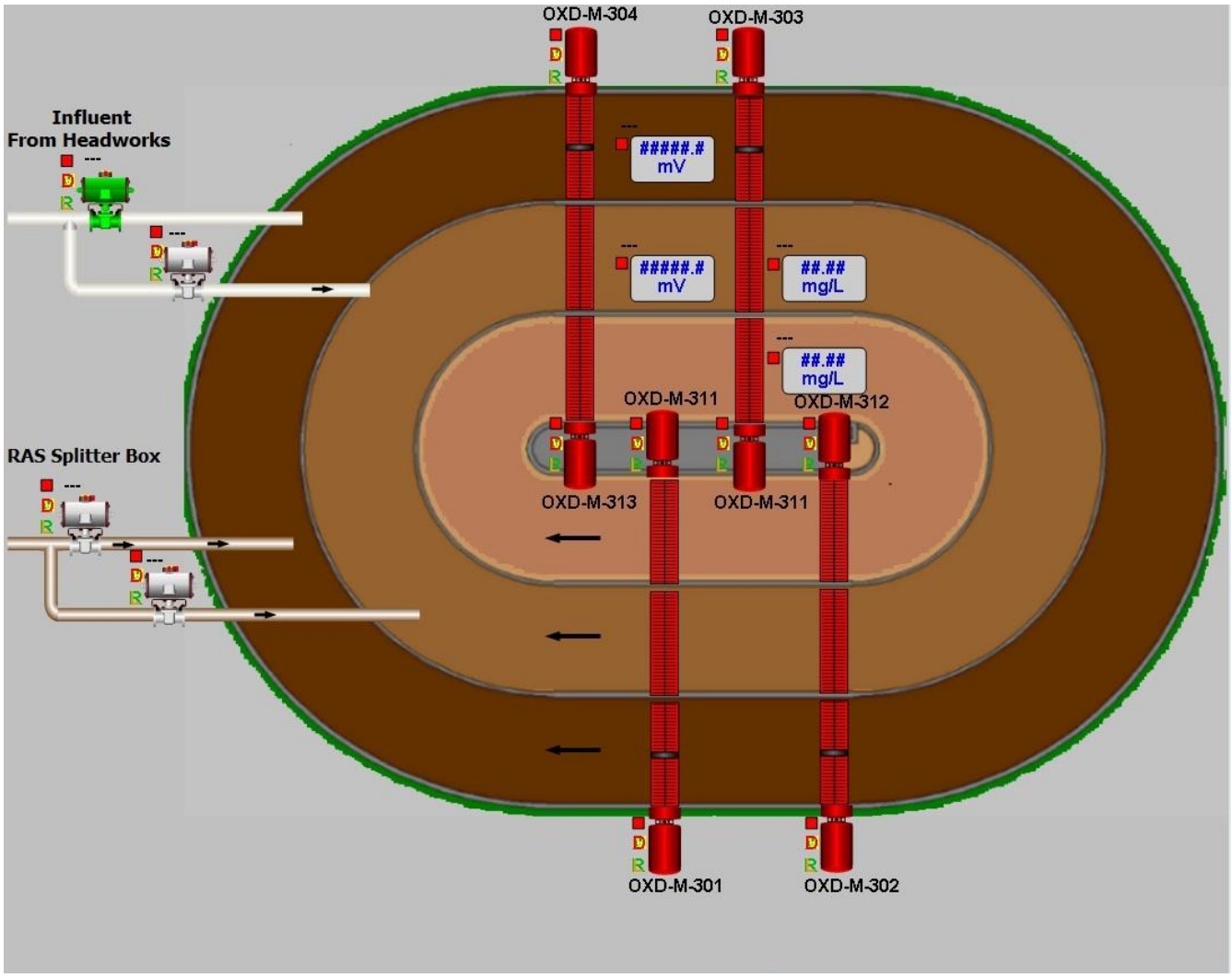
b. Control System

1. The central control system for the SmartBNR Aeration Control is based on the Allen Bradley Control Logix platform. The central processing unit (CPU) is located in the main PLC enclosure along with various analog and digital input and output modules that are used to control the aerator motors and various processes.
2. Control of the VFD's is via Ethernet while the influent valves and instruments are connected to I/O modules in the Control Logix rack.
3. The operator interface for this system is built in to the Wonderware System Platform being supplied by the system integrator. Detail screens for the Orbal™ were provided to the system integrator for incorporation into the Wonderware system.

III. Operation

The primary operation of all of the equipment included in the SmartBNR processes will require that all equipment be placed into AUTO or REMOTE modes at the MCC or at the individual piece of equipment. This will ensure that the PLC & control system will operate properly and allow the logic to determine the proper state of each piece of equipment. If a piece of equipment needs to be taken out of service for any reason, it should be placed in the OFF position on the SCADA system to prevent any nuisance alarms.

a. Overview



The main SmartBNR Overview screen gives the operator a quick overview of nearly all of the equipment controlled by the SmartBNR Process control system.

Current readings from each sensor are updated continuously and displayed near the associated instrument.

Status of each motor is displayed similar to other equipment on the SCADA by coloring the related equipment. Green equipment is considered to be currently in operation, such as “Running” or “Open”. Red equipment is currently “Off” or “Closed”. Flashing yellow indicates the device is currently “failed”.

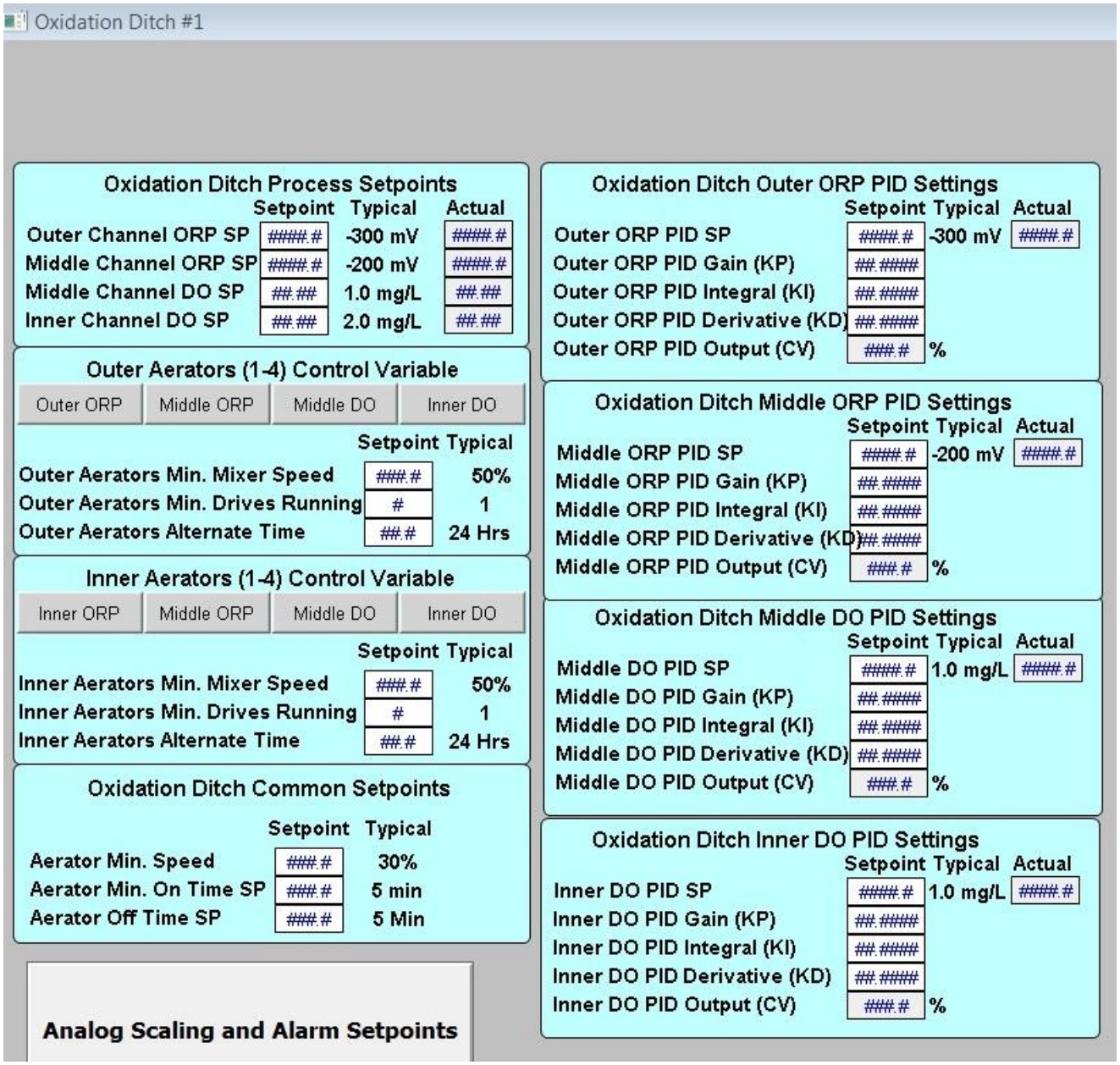
The orbal overview screen is embedded with pop-ups for each Aerator, Blower, Valve and instrument. Controls are provided in a familiar ON-OFF-AUTO fashion, mimicking a physical three position selector switch. The control of this switch is typical of others found on the SCADA system. Consult the system integration or SCADA manual for additional information related to screen navigation and control. Each motor also has a run time meter (RTM) located. These run time meters are stored on the PLC, so they may not match the RTMs found on the MCCs, due to running the motors prior to starting up the PLC.

The VFD controls can be accessed by pressing on the associated aerator as with other motors on the SCADA screen. Each VFD has an entry field for a “Manual Speed” Set point. Pressing the corresponding entry field (the white box) will bring up a numeric keypad as shown below. The Aerator speeds can be entered in any whole number value from 0 to 100%. To accept the value change, the user must press the enter/return key similar to one found on a physical keyboard. This manual speed is used when the motor is placed in the ON position.

When the drive is in AUTO mode, this speed will be determined by the SmartBNR process logic. The current ORP and DO levels are displayed on the screen; these values are used in determining the speed and number of aerators to run.

The aerators are turned ON and OFF based on the ORP or DO reading in the associated aeration basin. The first automated drive called to run is the drive that has been off the longest. The next automated drive to run will be the drive of the remaining drives not running. If both drives are running the first drive to stop will be the drive that has been running the longest. When a second drive is called to run, the first drive will ramp down to the starting speed of the second drive and they will ramp up together. Both drives will ramp up and down together.

b. SmartBNR Settings


Oxidation Ditch #1
Oxidation Ditch Process Setpoints
Setpoint Typical Actual
Outer Channel ORP SP ####.# -300 mV ####.#
Middle Channel ORP SP ####.# -200 mV ####.#
Middle Channel DO SP ##.## 1.0 mg/L ##.##
Inner Channel DO SP ##.## 2.0 mg/L ##.##
Outer Aerators (1-4) Control Variable
Outer ORP
Middle ORP
Middle DO
Inner DO
Setpoint Typical
Outer Aerators Min. Mixer Speed ###.# 50%
Outer Aerators Min. Drives Running # 1
Outer Aerators Alternate Time ##.# 24 Hrs
Inner Aerators (1-4) Control Variable
Inner ORP
Middle ORP
Middle DO
Inner DO
Setpoint Typical
Inner Aerators Min. Mixer Speed ###.# 50%
Inner Aerators Min. Drives Running # 1
Inner Aerators Alternate Time ##.# 24 Hrs
Oxidation Ditch Common Setpoints
Setpoint Typical
Aerator Min. Speed ###.# 30%
Aerator Min. On Time SP ###.# 5 min
Aerator Off Time SP ###.# 5 Min
Analog Scaling and Alarm Setpoints
Oxidation Ditch Outer ORP PID Settings
Setpoint Typical Actual
Outer ORP PID SP ####.# -300 mV ####.#
Outer ORP PID Gain (KP) ##.####
Outer ORP PID Integral (KI) ##.####
Outer ORP PID Derivative (KD) ##.####
Outer ORP PID Output (CV) ###.# %
Oxidation Ditch Middle ORP PID Settings
Setpoint Typical Actual
Middle ORP PID SP ####.# -200 mV ####.#
Middle ORP PID Gain (KP) ##.####
Middle ORP PID Integral (KI) ##.####
Middle ORP PID Derivative (KD) ##.####
Middle ORP PID Output (CV) ###.# %
Oxidation Ditch Middle DO PID Settings
Setpoint Typical Actual
Middle DO PID SP ####.# 1.0 mg/L ####.#
Middle DO PID Gain (KP) ##.####
Middle DO PID Integral (KI) ##.####
Middle DO PID Derivative (KD) ##.####
Middle DO PID Output (CV) ###.# %
Oxidation Ditch Inner DO PID Settings
Setpoint Typical Actual
Inner DO PID SP ####.# 1.0 mg/L ####.#
Inner DO PID Gain (KP) ##.####
Inner DO PID Integral (KI) ##.####
Inner DO PID Derivative (KD) ##.####
Inner DO PID Output (CV) ###.# %

The SmartBNR Settings screen is used to control the automatic SmartBNR process. All of the white entry fields operate just as the manual speed set point on the SmartBNR Overview screen, clicking in the white entry field will for changing the value.

Typical values displayed are displayed as a reference point for system startup, but it may be necessary to stray from these values depending on the current influent and effluent conditions.

The basic idea is that each drive can be adjusted to provide 0 to 100% aeration, and virtually any speed in between. For motor cooling purposes, typically the minimum speed will be no less than 33% of the drive capacity. For example, using two drives in a single oxidation ditch, the total possible aeration can range from 0 to 200% as described below. When more than one drive is running, they will be kept at equal speeds and ramped up and down as required by the PID output. Basin mixing requirements will typically call for at least one drive running at 30% speed, or two drives running at a minimum 60% speed, so the range of D.O./ORP control may not go as low as described here.

Decreasing D.O. or ORP Situation:

- Assuming that only one drive is running at its minimum speed, as the D.O or ORP. decreases, the PID algorithm will ramp up the one VFD that is currently running at its minimum speed. Once that VFD has reached its maximum speed (100% or 60Hz), and more aeration is still required, a second VFD will turn on. The first drive will then slow to either its minimum speed set point or 50%, whichever is higher, and the second drive will speed up to its minimum speed or 50%, whichever is higher.
- As the D.O./ORP continues decreasing or remaining below the set point, both drives will ramp up to 100%.
- If the D.O./ORP continues to decrease or remain below the set point, a third drive will start and all three drives will reduce to their minimum speeds. They will ramp up in unison until all three drives are at 100%. This process continues until all 6 drives are running at 100%; or a total of 600% aeration.

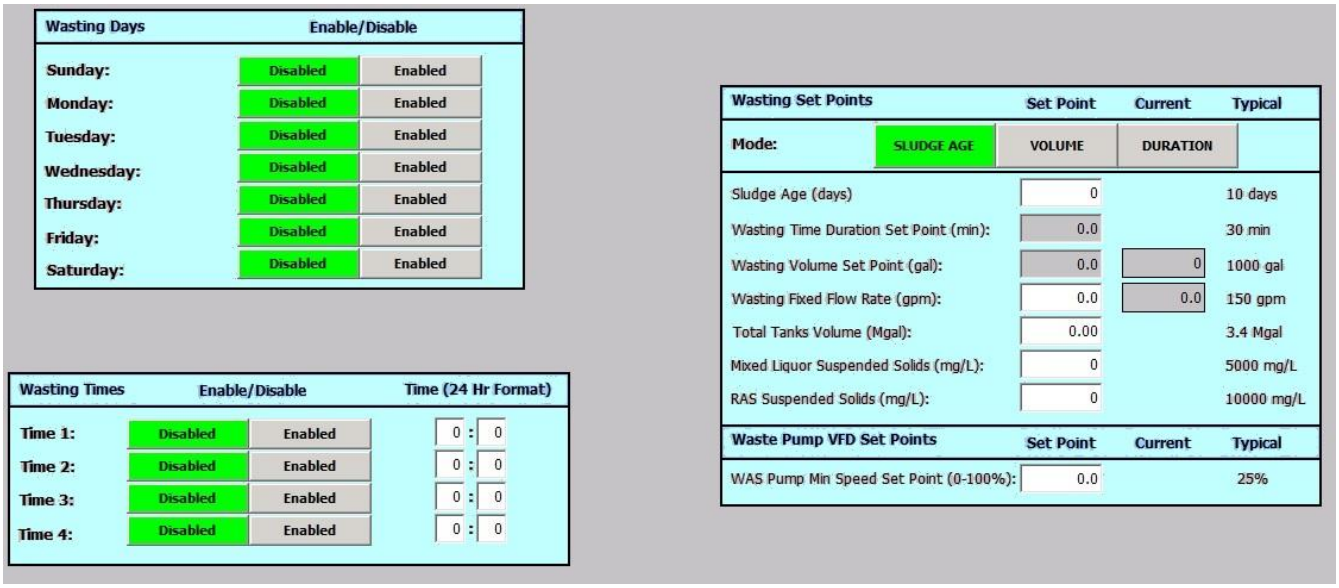
Increasing D.O. or ORP Situation:

- Assuming that all 6 drives are running, and the D.O./ORP begins to increase, the PID algorithm will begin to ramp all of the drives down in unison, and assuming the D.O./ORP continues increasing or stays above the set point, the drives will slow down to their minimum speed.
- If the D.O./ORP still remains high or continues increasing, on aerator will shut off, and the remaining aerators will ramp back up to maintain a smooth transition. The remaining aerators will again ramp down assuming the D.O./ORP continues to increase or remain above the set point. This process is repeated until a single aerator is running at minimum speed or until oxygen demand increases once again.

<u>Set Points:</u>

- Outer/Middle ORP Set Point (mV): Allows the operator to enter the desired ORP level to be maintained in the outer or middle oxidation basin. The aerators will be turned on and off and ramped up and down based on the current ORP reading to maintain the desired ORP set point.
- Middle/Inner D.O. Set Point (mg/L): Allows the operator to enter the desired DO level to be maintained in the middle or inner oxidation ditch. The aerators will be turned on and off and ramped up and down based on the current DO reading to maintain the desired DO set point.
- Inner/Outer Drives Control Instrument: The outer and inner aerators can be set up to control oxidation based on the DO in the middle or inner channel or ORP in the middle or outer channel. The default control probe for the outer aerators is the ORP probe in the outer channel. The inner aerators are set up by default to use the DO probe in the inner channel.
- Inner/Outer Drives Minimum Mix Speed: This is the minimum speed that a single drive must run at to maintain mixing within the channel. Mixing must be maintained at all times so that settling of solids does not occur in the aeration channels.
- Inner/Outer Min Drives On: The default would require at least one VFD controlled aerator to be run in the system. However, there may be cases where the plant may require a minimum of 2 or 3 drives running; even if oxygen demand is exceeded.
- Inner/Outer Min Speed Set Point (0 – 100%): Allows the operator to set the minimum speed the aerators will be allowed to ramp down to.
- Inner/Outer Alternate Time: If all aerators are not in use, this is the time required between alternating between running aerators. This is to maintain an even runtime between aerators in each channel and to not overwork a single drive.
- Inner/Outer Drives Min On/Off Time: This is the minimum amount of time that a drive must be either on or off before cycling on or off again. It is used to make sure that drives do not cycle on and off too often which can damage the motor.
- Storm Flow Mode settings:
  - Storm Flow mode set points: When this flow set point is reached, a timer will start. When the timer reaches the Delay set point, the Storm Flow Mode active indicator is highlighted and the middle channel influent valve opens. When this valve reaches its full open position, then the outer channel influent valve closes.
  - Storm Flow mode Reset set points: When the flow drops below the reset set point, a delay timer starts. When the timer completes, the Storm Flow mode resets, the outer channel influent valve opens, and once proven open, the middle channel influent valve closes.

c. Wasting Settings



The wasting settings screen allows the operator to customize how the system wastes. Wasting can be enabled or disabled for each day of the week and enabled for up to 4 times per day. The PLC calculated how much to waste based on values entered in the "Wasting Set Points" section as well as what mode of operation is selected. The total tanks volume should include all aeration tanks at their normal water level. This volume is multiplied by the suspended solids concentration to determine the bio-mass in the aeration tanks. In addition, there is a sludge blanket level entry for each clarifier. This level (times R^2PI) will be multiplied by ½ the RAS concentration, and added to the sludge volume in the aeration tanks to determine total bio-mass in the system. The system can waste in 3 different modes:

- Sludge Age: The operator enters a Sludge Age that he/she would like to maintain along with the Tanks Volume, MLSS, RAS SS, and a Fixed Wasting Flow Rate. The PLC then calculates how much to waste when a wasting cycle is entered.
- Volume: The operator enters a volume to waste and a fixed flow rate to waste at. The system will waste until that volume is reached.
- Duration: The operator must enter a duration and a fixed flow rate to waste at. The system will calculate how much volume to waste based on these values, and the system will waste until this volume is reached.

d. RAS pump control

RAS pumps are controlled based on either influent flow ratio or simply a flow setpoint. In the influent flow ratio mode, the influent flow is multiplied by a operator entered ratio, and the number of pumps required run to maintain this flow. A minimum and maximum flow setpoint

are entered to prevent RAS going to full speed or no speed during periods of extreme changes in influent flow.

e. PID Set Points

The proportional-integral-derivative (PID) settings are used to control the logic behind the PID control loops, and how they will react to changes in the process variable (PV). These settings should typically only be adjusted with guidance from Evoqua Water Technologies

A PID controller is a generic control loop feedback mechanism. A PID controller calculates an "error" value as the difference between a measured process variable (PV) and the desired set point (SP). The controller attempts to minimize the error by adjusting the output control variable (CV). For best performance, the PID parameters used in the calculation must be tuned according to the nature of the system to be controlled.

- Set Point (SP): Refers to the current set point of the PID loop. The PID loop monitors the Process Variable and Adjusts the Output (CV) to achieve the desired Set Point.
- Process Var (PV): The current value of the Process Variable (PV).
- Gain (P): Determines the reaction to the current error. The gain makes a change to the output that is proportional to the current error value. The proportional response can be adjusted by multiplying the error by a constant (P) called the proportional gain. A higher proportional gain results in a large change in the output (CV) for a given change in error.
- Integral (I): Is proportional to both the magnitude of the error and the duration of the error. Summing the instantaneous error over time (integrating the error) gives an accumulated offset that should have been corrected previously. The accumulated error is then multiplied by the integral gain (I) and added to the output (CV). A longer period of time will cause the PID output to react slower to changes in the process variable (PV).
- Derivative (D): The rate of change of the process error is calculated by determining the slop of the error over time and multiplying this rate of change by the derivative gain (D). The derivative term slows the rate of change of the output (CV) and this effect is most noticeable close to the controller set point (SP). Derivative control is used to reduce the magnitude of the overshoot produced by the integral component and improve the combined controller-process stability. A longer period of time will again cause the PID output to react slower to changes in the process variable (PV).
- Deadband (DB): Refers to the amount of error that is acceptable prior to changing the output. A larger dead band will let the process variable drift further from the set point before allowing the PID controller to increase or decrease the output.
- Output (CV): Refers to the current output (%) of the PID loop, and is used to control the associated equipment.

A well-tuned PID loop will react quickly when abrupt changes are seen on the process variable, and should stabilize to a value at or near the set point within one or two oscillations. Occasionally, effluent flow conditions can be somewhat erratic, which, at times, can cause the PID control to over-

compensate for the changes in the process variable, leading to an oscillating output that can take an extended period of time to stabilize.

Typically, the PID controller is set up to withstand a wide range of effluent conditions, and react well with little to no oscillation. Should oscillations begin to occur, it may be necessary to "re-tune" the PID loop to meet those current conditions. Caution should be taken when adjusting the PID settings as incorrect adjustments can lead to very poor performance. These are some good "rules of thumb" to go by when adjusting the PID settings:

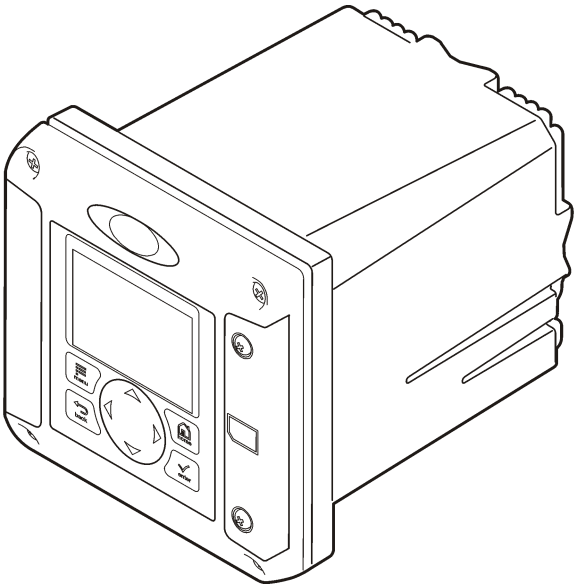
- Adjust only one parameter at a time and monitor the outcome over a reasonable length of time, at least one full cycle. Changing more than one parameter and changing them frequently will not give an accurate idea of how the changes are actually affecting the process.
- If large swings occur, where the process variable passes the set point by a large amount, either in the positive or the negative direction of the set point, try reducing the gain. Reducing the gain can also assist in settling out oscillation.
- If the output is rapidly increasing and decreasing when changes occur in the process variable, often times causing oscillation, try increasing the reset time (integral). This will make the system less sensitive to small changes in error, but should not be increased so much that the system fails to react quickly to large changes in error.
- If the output seems to take an extended period of time to settle down and stabilize, try decreasing the rate time (derivative). This should make the system seek out the set point quicker, but too low of a rate time may cause oscillation.

For additional information on operation of screens see the system integration manual.

DOC023.97.80040

sc200 Controller

08/2013, Edition 6



Basic User Manual

English 3

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Additional information

Additional information is available on the manufacturer's website.

Specifications

Specifications are subject to change without notice.

Specification	Details
Component description	Microprocessor-controlled and menu-driven controller that operates the sensor and displays measured values.
Operating temperature	-20 to 60 ºC (-4 to 140 ºF); 95% relative humidity, non-condensing with sensor load <7 W; -20 to 50 ºC (-4 to 104 ºF) with sensor load <28 W
Storage temperature	-20 to 70 ºC (-4 to 158 ºF); 95% relative humidity, non-condensing
Enclosure[1]	NEMA 4X/IP66 metal enclosure with a corrosion-resistant finish
Power requirements	**AC powered controller:** 100-240 VAC ±10%, 50/60 Hz; Power 50 VA with 7 W sensor/network module load, 100 VA with 28 W sensor/network module load (optional Modbus, RS232/RS485, Profibus DPV1 or HART network connection).
	24 VDC powered controller: 24 VDC—15%, + 20%; Power 15 W with 7 W sensor/network module load, 40 W with 28 W sensor/network module load (optional Modbus, RS232/RS485, Profibus DPV1 or HART network connection).
Altitude requirements	Standard 2000 m (6562 ft) ASL (Above Sea Level)
Pollution degree/Installation category	Polution Degree 2; Installation Category II
Outputs	Two analog (0-20 mA or 4-20 mA) outputs. Each analog output can be assigned to represent a measured parameter such as pH, temperature, flow or calculated values. Optional module supplies three additional analog outputs (5 total).
Relays	Four SPDT, user-configured contacts, rated 250 VAC, 5 Amp resistive maximum for the AC powered controller and 24 VDC, 5A resistive maximum for the DC powered controller. Relays are designed for connection to AC Mains circuits (i.e., whenever the controller is operated with 115 - 240 VAC power) or DC circuits (i.e., whenever the controller is operated with 24 VDC power).
Dimensions	½ DIN—144 x 144 x 180.9 mm (5.7 x 5.7 x 7.12 in.)
Weight	1.7 kg (3.75 lb)
Compliance information[2]	CE approved (with all sensor types). Listed for use in general locations to UL and CSA safety standards by ETL (with all sensor types). Certain AC mains powered models are listed for use in general safety locations to UL and CSA safety standards by Underwriters Laboratories (with all sensor types).
Digital communication	Optional Modbus, RS232/RS485, Profibus DPV1 or HART network connection for data transmission

Specification	Details
Data logging	Secure Digital Card (32 GB maximum) or special RS232 cable connector for data logging and performing software updates. The controller will keep approximately 20,000 data points per sensor.
Warranty	2 years

[1] Units that have the Underwriters Laboratories (UL) certification are intended for indoor use only and do not have a NEMA 4X/IP66 rating.
[2] DC powered units are not listed by UL.

General information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.

Safety information

NOTICE

The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

Use of hazard information

⚠ DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
	This symbol indicates that a risk of electrical shock and/or electrocution exists.
	This symbol indicates the presence of devices sensitive to Electro-static Discharge (ESD) and indicates that care must be taken to prevent damage with the equipment.
	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of-life equipment to the Producer for disposal at no charge to the user.

Certification

Canadian Radio Interference-Causing Equipment Regulation, IECS-003, Class A:

Supporting test records reside with the manufacturer.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numèrique de classe A répond à toutes les exigences de la réglementation canadienne sur les équipements provoquant des interférences.

FCC Part 15, Class "A" Limits

Supporting test records reside with the manufacturer. The device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

1. The equipment may not cause harmful interference.
2. The equipment must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at their expense. The following techniques can be used to reduce interference problems:

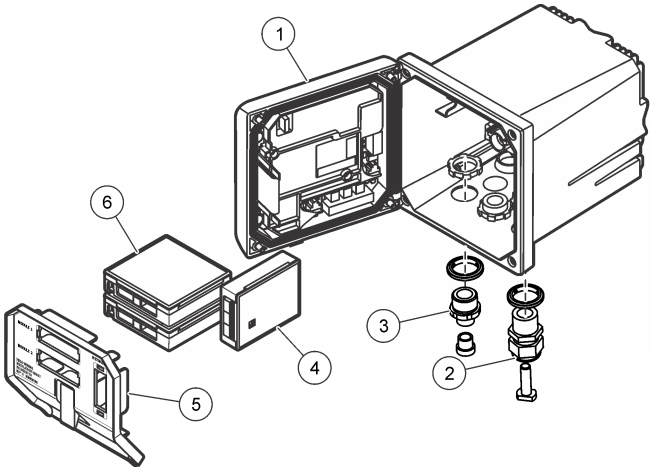
1. Disconnect the equipment from its power source to verify that it is or is not the source of the interference.
2. If the equipment is connected to the same outlet as the device experiencing interference, connect the equipment to a different outlet.
3. Move the equipment away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

Product overview

The controller displays sensor measurements and other data, can transmit analog and digital signals, and can interact with and control other devices through outputs and relays. Outputs, relays, sensors and sensor modules are configured and calibrated through the user interface on the front of the controller.

Figure 1 shows the product components. Components may vary according to controller configuration. Contact the manufacturer if parts are damaged or missing.

Figure 1 System components



1 Controller	**4** Network module (optional)
2 Strain relief assembly (optional depending on controller version)	**5** High-voltage barrier
3 Digital connection fitting (optional depending on controller version)	**6** Sensor modules (optional)

Sensors and sensor modules

The controller accepts up to a maximum of two sensor modules or two digital sensors (depending on the controller configuration), along with one communication module. A single digital sensor and a single sensor module can be installed in combination. A variety of sensors can be wired to the sensor modules. Sensor wiring information is given in the specific sensor manuals and in the user instructions for specific modules.

Relays outputs and signals

The controller has four configurable relay switches and two analog outputs. An optional analog output module can increase the number of analog outputs to five.

Device scans

With two exceptions, the controller automatically scans for connected devices without user input when it is powered on. The first exception is when the controller is powered on for the first time before initial use. The second exception is after the controller configuration settings have been set to their default values and the controller is powered on. In both cases, the controller first displays the language, date and time edit screens. After the language, date and time entries are accepted, the controller performs a device scan. Refer to Connect a digital sc sensor on page 21 for instructions about how to scan for devices when the controller is already powered on.

Controller enclosure

The controller enclosure is NEMA 4X/IP66-rated and has a corrosion-resistant finish designed to withstand corrosive environmental constituents such as salt spray and hydrogen sulfide. Protection against environmental damage is strongly recommended for outdoor use.
Note: *Units that have the Underwriters Laboratories (UL) certification are intended for indoor use only and do not have a NEMA 4X/IP66 rating.*

Controller mounting options

The controller can be mounted to a panel, to a wall or to a vertical or horizontal pipe. A neoprene sealing gasket is included and can be used to reduce vibration. The gasket can be used as a template for panel mounting before the inner gasket component is separated.

Installation

Mounting components and dimensions

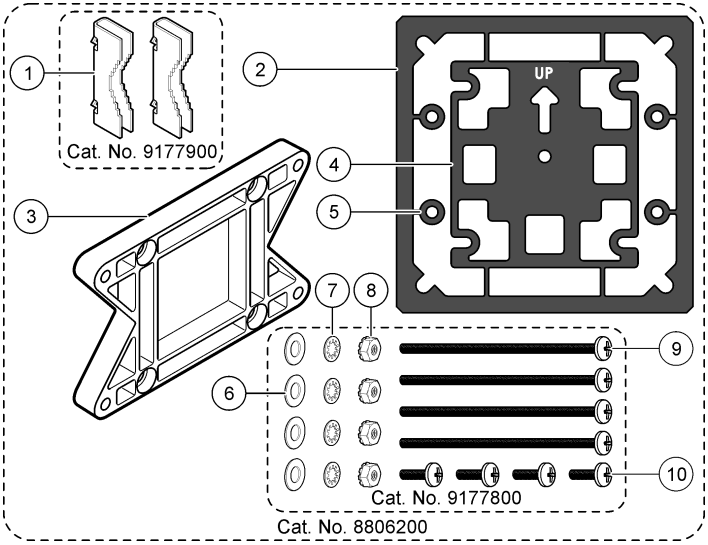
⚠ CAUTION
Personal injury hazard. Only qualified personnel should conduct the tasks described in this section of the manual.

The controller can be installed on a surface, panel or pipe (horizontal or vertical). For mounting options and instructions, refer to Figure 2, Figure 3 on page 9, Figure 4 on page 10, Figure 5 on page 11 and Figure 6 on page 12.

For horizontal pipe mounts, the mounting feet (Figure 2) must be attached to the mounting bracket in a vertical position.

For both horizontal and vertical pipe mounts, attach the mounting bracket to the controller as shown in Figure 5 on page 11.

Figure 2 Mounting components



1 Mounting foot (2x)	**6** Flat washer, ¼-inch ID (4x)
2 Sealing gasket for panel mount, Neoprene	**7** Lock washer, ¼-inch ID (4x)
3 Bracket for wall and pipe mounting	**8** M5 x 0.8 Keps hexnut (4x)
4 Vibration isolation gasket for pipe mount	**9** Pan head screws, M5 x 0.8 x 100mm (4x) (Used for variable diameter pipe mount installations)
5 Vibration isolation washer for pipe mount (4x)	**10** Pan head screws, M5 x 0.8 x 15 mm (4x)

Note: *A bracket for panel mounting is available as an optional accessory.*

Controller mounting

Figure 3 Surface mounting dimensions

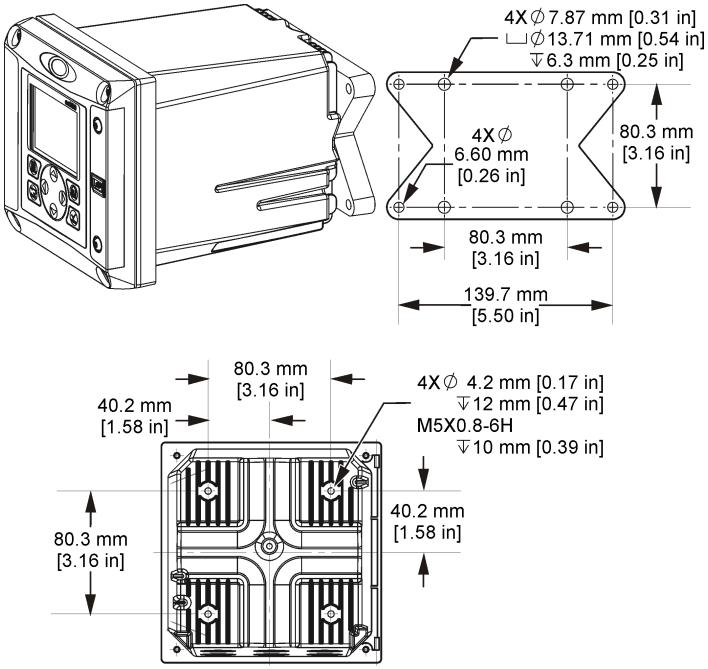
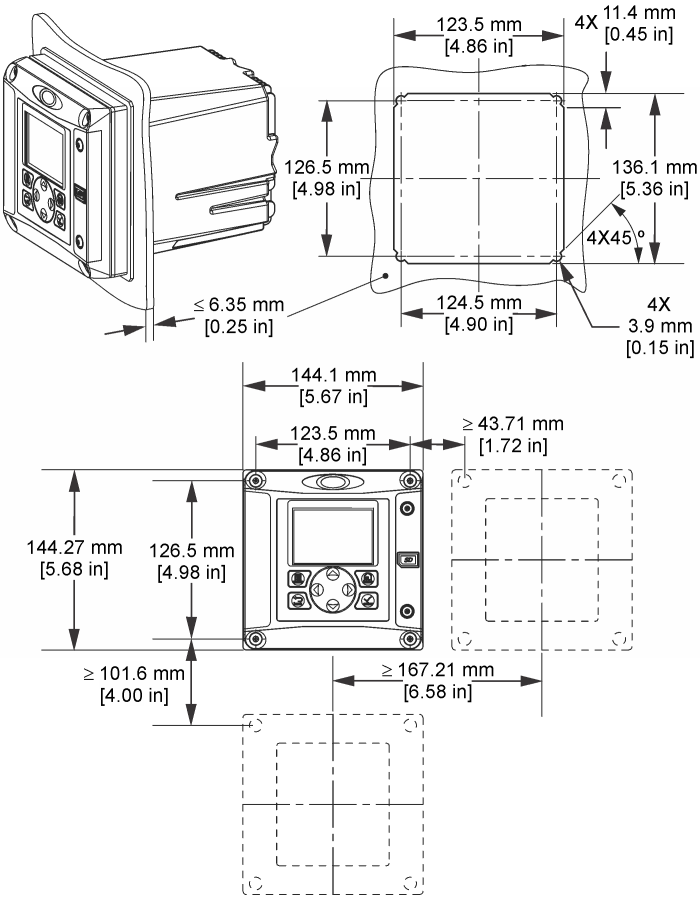


Figure 4 Panel mounting dimensions



Note: *If using the bracket (optional) for panel mounting, push the controller through the hole in the panel and then slide the bracket over the controller on the back side of the panel. Use the four 15 mm pan head screws (supplied) to attach the bracket to the controller and secure the controller to the panel.*

Figure 5 Pipe mounting (vertical pipe)

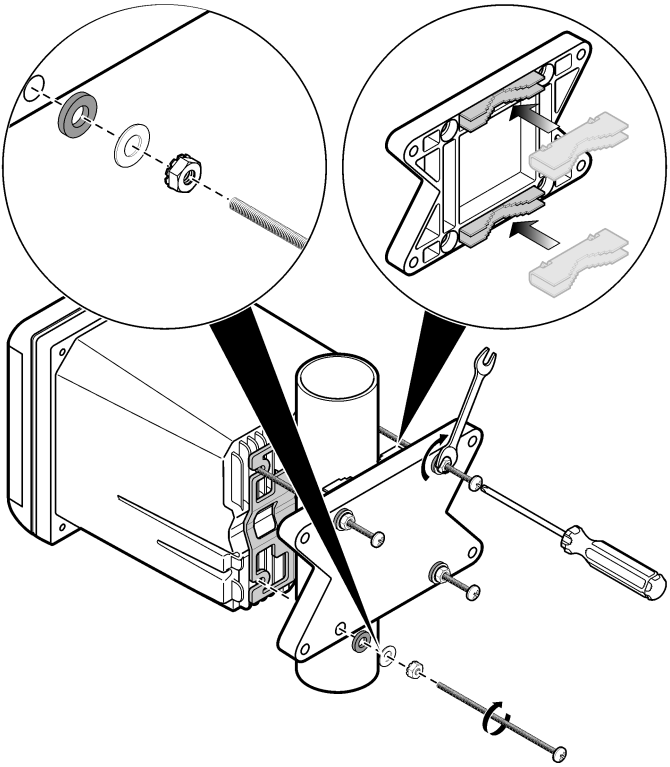
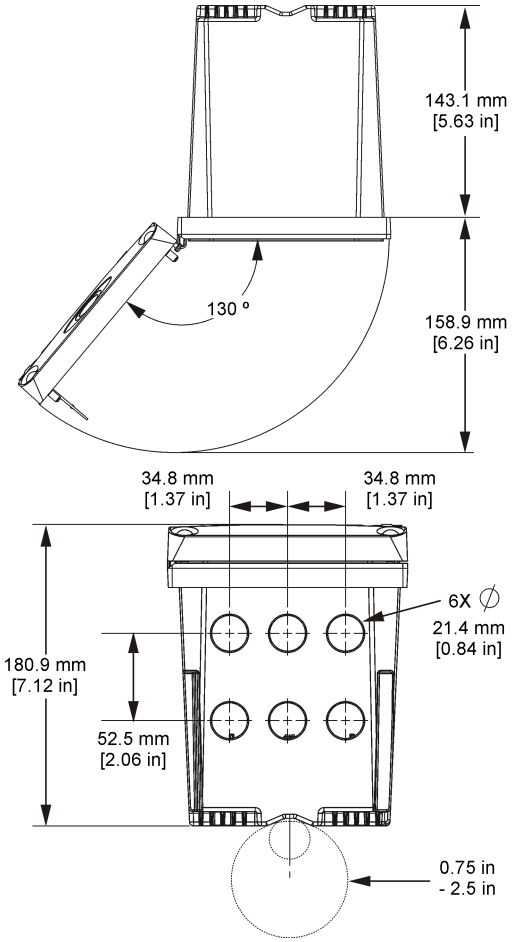


Figure 6 Top and bottom views



High-voltage barrier

High-voltage wiring for the controller is located behind the high-voltage barrier in the controller enclosure. The barrier must remain in place except when installing modules or when a qualified installation technician is wiring for power, alarms, outputs or relays. Do not remove the barrier while power is applied to the controller.

Electrostatic discharge (ESD) considerations

NOTICE	
	Potential Instrument Damage. Delicate internal electronic components can be damaged by static electricity, resulting in degraded performance or eventual failure.

Refer to the steps in this procedure to prevent ESD damage to the instrument:

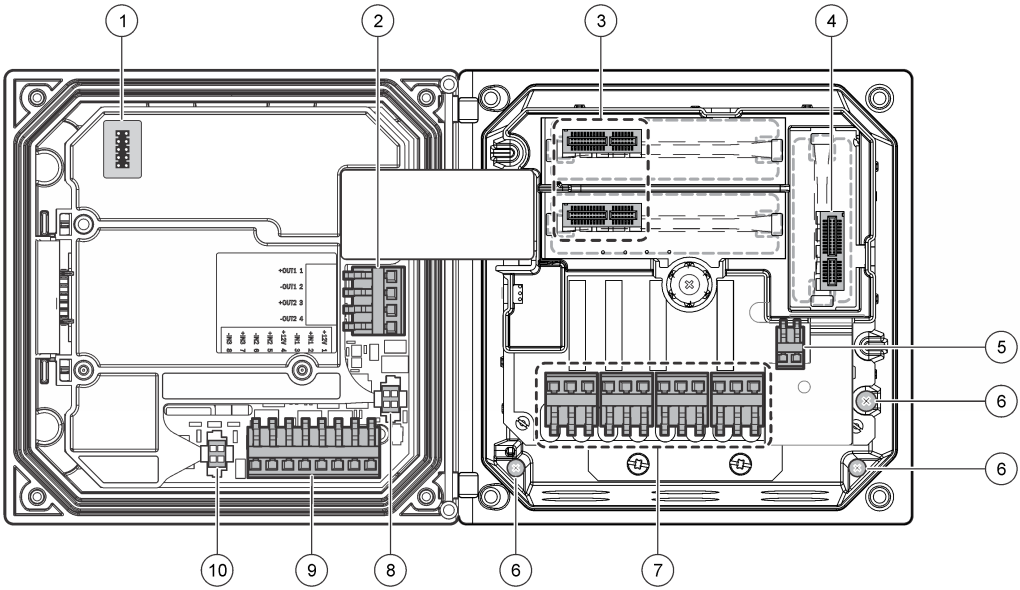
- Touch an earth-grounded metal surface such as the chassis of an instrument, a metal conduit or pipe to discharge static electricity from the body.

- Avoid excessive movement. Transport static-sensitive components in anti-static containers or packages.
- Wear a wrist strap connected by a wire to earth ground.
- Work in a static-safe area with anti-static floor pads and work bench pads.

Wiring overview

Figure 7 shows an overview of the wiring connections inside the controller with the high voltage barrier removed. The left side of the figure shows the back side of the controller cover.
Note: *Remove connector caps from the connectors before module installation.*

Figure 7 Wiring connections overview



1 Service cable connection	**5** AC and DC power connector[1]	**9** Discrete input wiring connector[1]
2 4-20 mA output[1]	**6** Ground terminals	**10** Digital sensor connector[1]
3 Sensor module connector	**7** Relay connections[1]	
4 Communication module connector (e.g., Modbus, Profibus, HART, optional 4-20 mA module, etc.)	**8** Digital sensor connector[1]	

[1] Terminals can be removed for improved access.

Wiring for power

⚠ WARNING

Potential Electrocution Hazard. Always disconnect power to the instrument when making electrical connections.

⚠ WARNING

Potential Electrocution Hazard. If this equipment is used outdoors or in potentially wet locations, a **Ground Fault Interrupt** device must be used for connecting the equipment to its mains power source.

⚠ DANGER

Electrocution Hazard. Do not connect AC power to a 24 VDC powered model.

⚠ WARNING

Potential Electrocution Hazard. A protective earth (PE) ground connection is required for both 100-240 VAC and 24 VDC wiring applications. Failure to connect a good PE ground connection can result in shock hazards and poor performance due to electromagnetic interferences. ALWAYS connect a good PE ground to the controller terminal.

NOTICE

Install the device in a location and position that gives easy access to the disconnect device and its operation.

The controller can be purchased as either a 100-240 VAC powered model or a 24 VDC powered model. Follow the appropriate wiring instructions for the purchased model.

The controller can be wired for line power by hard-wiring in conduit or wiring to a power cord. Regardless of the wire used, the connections are made at the same terminals. A local disconnect designed to meet local electrical code is required and must be identified for all types of installation. In hard-wired applications, the power and safety ground service drops for the instrument must be 18 to 12 AWG.

Notes:

- The voltage barrier must be removed before making any electrical connections. After making all connections, replace the voltage barrier before closing the controller cover.
- A sealing type strain relief and a power cord less than 3 meters (10 feet) in length with three 18-gauge conductors (including a safety ground wire) can be used to maintain the NEMA 4X/IP66 environmental rating.
- Controllers can be ordered with AC power cords pre-installed. Additional power cords may also be ordered.
- The DC power source that supplies power to the 24 VDC powered controller must maintain voltage regulation within the specified 24 VDC-15% +20% voltage limits. The DC power source must also provide adequate protection against surges and line transients.

Wiring procedure

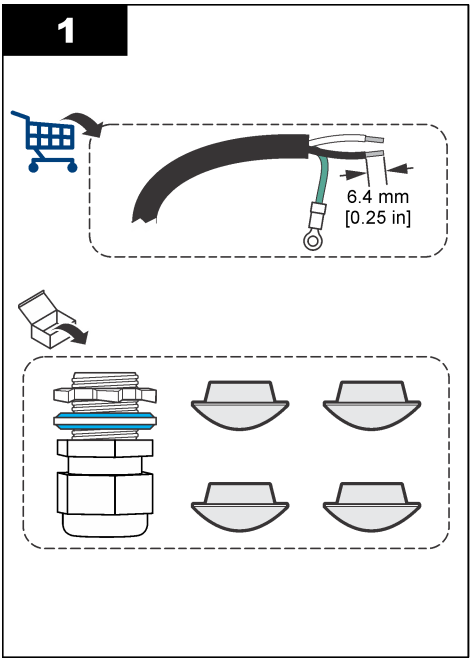
Refer to the illustrated steps that follow and Table 1 or Table 2 to wire the controller for power. Insert each wire into the appropriate terminal until the insulation is seated against the connector with no bare wire exposed. Tug gently after insertion to make sure that there is a secure connection. Seal any unused openings in the controller box with conduit opening sealing plugs.

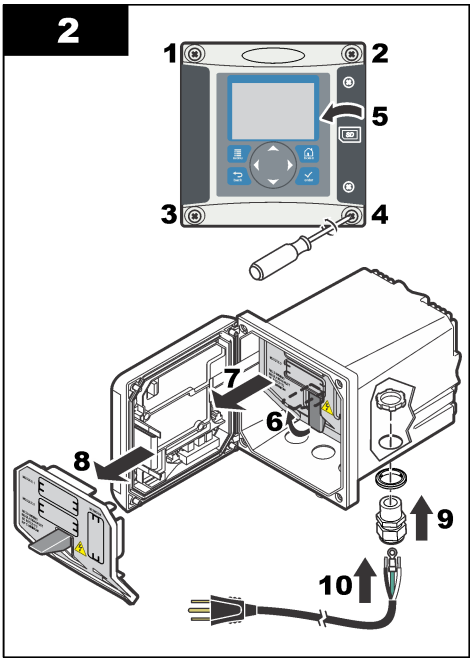
Table 1 AC power wiring information (AC powered models only)

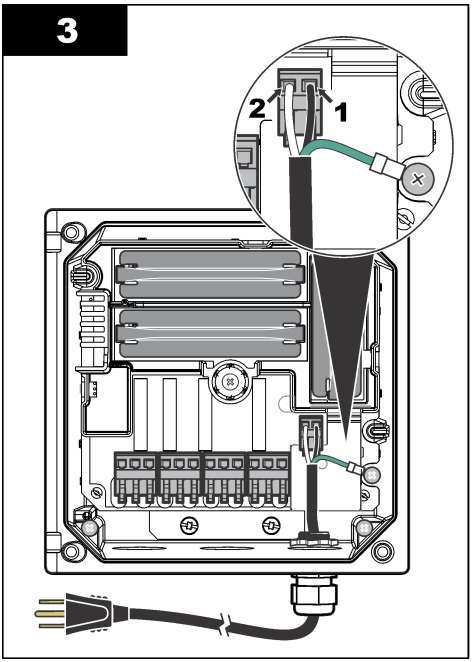
Terminal	Description	Color—North America	Color—EU
1	Hot (L1)	Black	Brown
2	Neutral (N)	White	Blue
—	Protective Earth (PE) Ground lug	Green	Green with yellow stripe

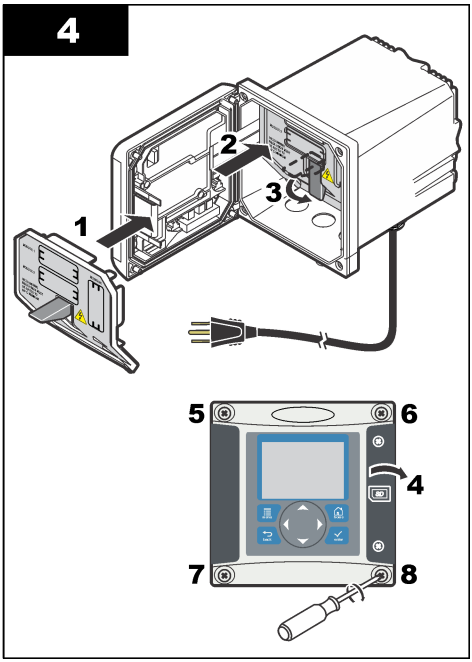
Table 2 DC power wiring information (DC powered models only)

Terminal	Description	Color—North America	Color—EU
1	+24 VDC	Red	Red
2	24 VDC return	Black	Black
—	Protective Earth (PE) Ground lug	Green	Green with yellow stripe









Alarms and relays

The controller is equipped with four unpowered, single pole relays rated 100-250 VAC, 50/60 Hz, 5 amp resistive maximum. Contacts are rated 250 VAC, 5 amp resistive maximum for the AC powered controller and 24 VDC, 5A resistive maximum for the DC powered controller. The relays are not rated for inductive loads.

Wiring relays

⚠ WARNING
Potential Electrocution Hazard. Always disconnect power to the instrument when making electrical connections.

⚠ WARNING
Potential fire hazard. The relay contacts are rated 5A and are not fused. External loads connected to the relays must have current limiting devices provided to limit current to < 5 A.

⚠ WARNING
Potential fire hazard. Do not daisy-chain the common relay connections or jumper wire from the mains power connection inside the instrument.

⚠ WARNING
Potential electrocution hazard. In order to maintain the NEMA/IP environmental ratings of the enclosure, use only conduit fittings and cable glands rated for at least NEMA 4X/IP66 to route cables in to the instrument.

AC line (100—250 V) powered controllers

The wiring compartment is not designed for voltage connections in excess of 250 VAC.

24 VDC powered controllers

⚠ WARNING

Potential electrocution hazard. AC mains powered controllers (115 V–230 V) are designed for relay connections to AC mains circuits (i.e., voltages greater than 16 V-RMS, 22.6 V-PEAK or 35 VDC).

⚠ WARNING

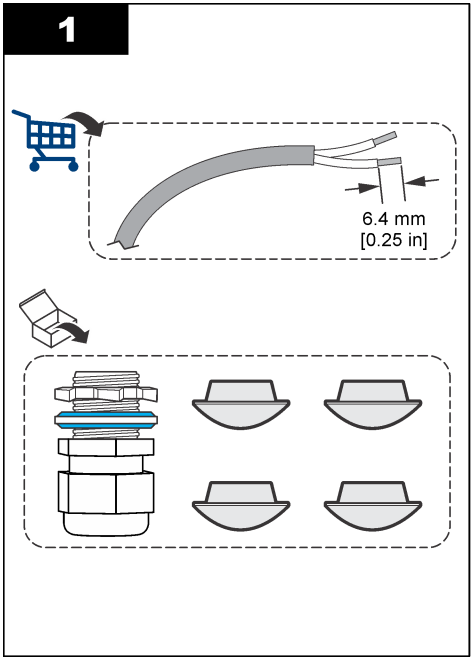
Potential electrocution hazard. 24 V powered controllers are designed for relay connections to low voltage circuits (i.e., voltages less than 16 V-RMS, 22.6 V-PEAK or 35 VDC).

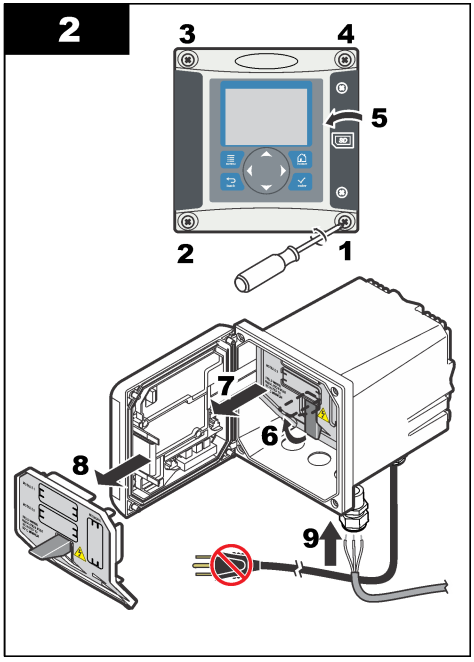
The 24 VDC controller relays are designed for the connection to low voltage circuits (i.e., voltages less than 30 V-RMS, 42.2 V-PEAK or 60 VDC). The wiring compartment is not designed for voltage connections above these levels.

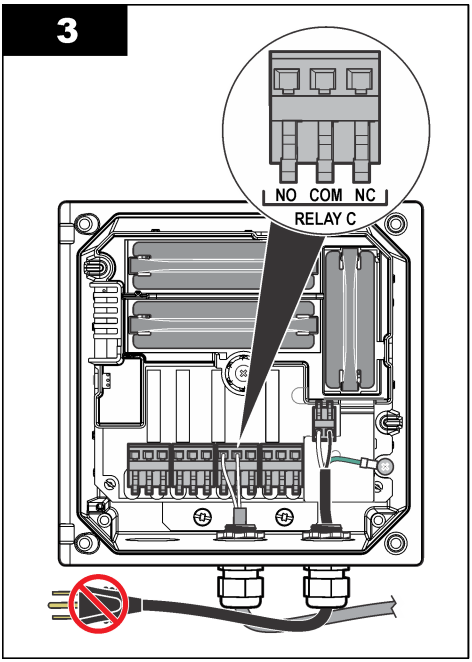
The relay connector accepts 18–12 AWG wire (as determined by load application). Wire gauge less than 18 AWG is not recommended.

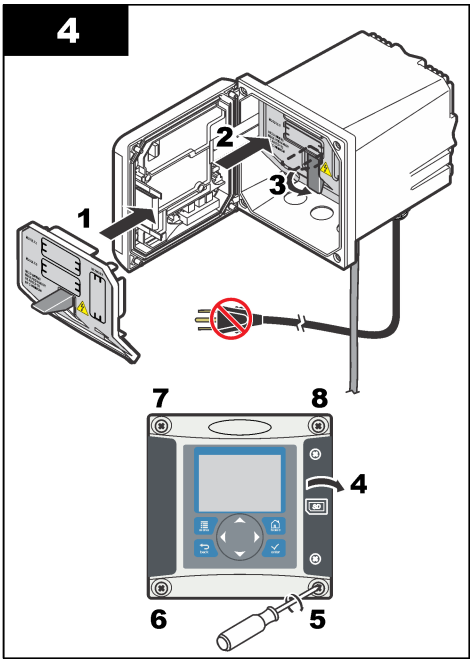
The Normally Open (NO) and Common (COM) relay contacts will be connected when an alarm or other condition is active. The Normally Closed (NC) and Common relay contacts will be connected when an alarm or other condition is inactive (unless the Fail Safe is set to Yes) or when power is removed from the controller.

Most relay connections use either the NO and COM terminals or the NC and COM terminals. The numbered installation steps show connection to the NO and COM terminals.









Analog output connections

⚠ WARNING

Potential Electrocution Hazard. Always disconnect power to the instrument when making electrical connections.

⚠ WARNING

Potential electrocution hazard. In order to maintain the NEMA/IP environmental ratings of the enclosure, use only conduit fittings and cable glands rated for at least NEMA 4X/IP66 to route cables in to the instrument.

Two isolated analog outputs (1 and 2) are provided (Figure 8). Such outputs are commonly used for analog signaling or to control other external devices.

Make wiring connections to the controller as shown in Figure 8 and Table 3.
Note: *Figure 8 shows the back of the controller cover and not the inside of the main controller compartment.*

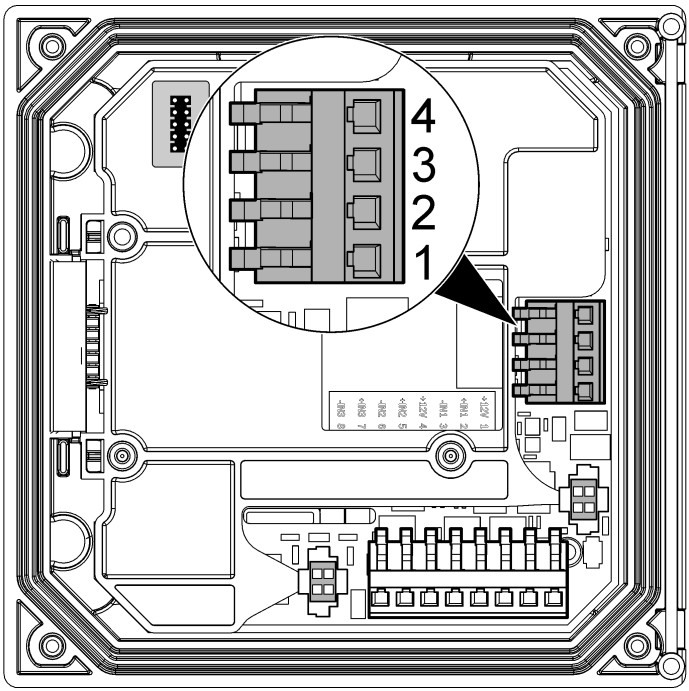
Table 3 Output connections

Recorder wires	Circuit board position
Output 2–	4
Output 2+	3
Output 1–	2
Output 1+	1

1. Open the controller cover.
2. Feed the wires through the strain relief.
3. Adjust the wire as necessary and tighten the strain relief.

4. Make connections with twisted-pair shielded wire and connect the shield at the controlled component end or at the control loop end.
   - Do not connect the shield at both ends of the cable.
   - Use of non-shielded cable may result in radio frequency emission or susceptibility levels higher than allowed.
   - Maximum loop resistance is 500 ohm.
5. Close the controller cover and tighten the cover screws.
6. Configure outputs in the controller.

Figure 8 Analog output connections



Discrete input wiring connections

⚠ WARNING

Potential Electrocution Hazard. Always disconnect power to the instrument when making electrical connections.

⚠ WARNING

Potential electrocution hazard. In order to maintain the NEMA/IP environmental ratings of the enclosure, use only conduit fittings and cable glands rated for at least NEMA 4X/IP66 to route cables in to the instrument.

Three discrete inputs are provided for switch closure inputs or logic level voltage inputs. Make wiring connections and configure jumper settings to the controller as shown in Figure 9, Table 4 and Figure 10.

Note: *Figure 9 shows the back of the controller cover and not the inside of the main controller compartment.*

Figure 9 Discrete input wiring connections

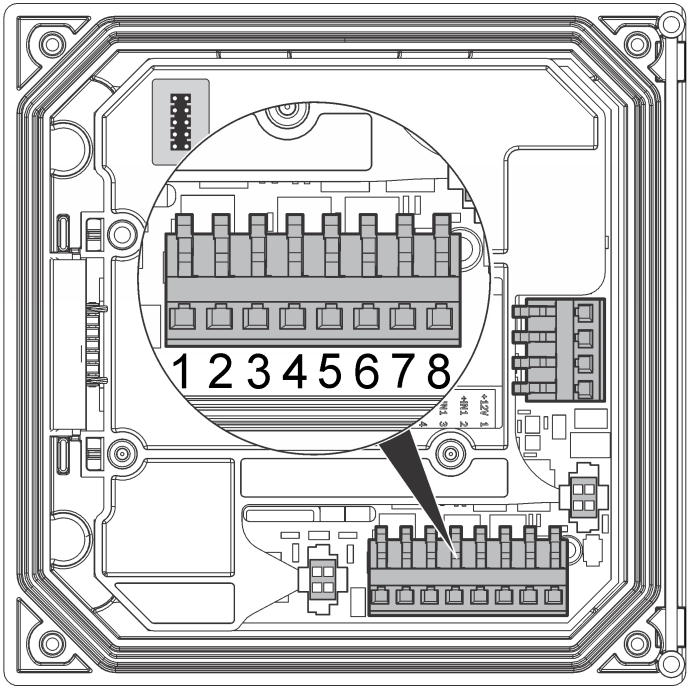
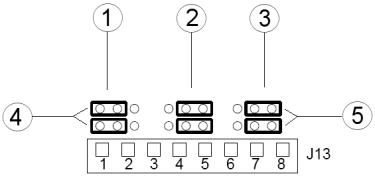


Table 4 Input connections

Discrete inputs	Connector position - Switch input	Connector position - Voltage input
Input 1+	3	2
Input 1-	2	3
Input 2+	6	5
Input 2-	5	6
Input 3+	8	7
Input 3-	7	8

Figure 10 Jumper settings



1 Input 1 configuration jumpers	**4** Jumpers positioned to the left for switch inputs
2 Input 2 configuration jumpers	**5** Jumpers positioned to the right for voltage inputs
3 Input 3 configuration jumpers	

1. Open the controller cover.
2. Feed the wires through the cable gland.
3. Adjust the wire as necessary and tighten the cable gland.
4. The jumpers are positioned immediately behind the connector. Remove the connector for improved access to the jumpers and configure the jumper settings according to the type of input as shown in Figure 10.
5. Close the controller cover and tighten the cover screws.
6. Configure inputs in the controller.

Note: *In* ***switch input*** *mode the controller supplies 12 volts to the switch and is not isolated from the controller. In* ***voltage input*** *mode the inputs are isolated from the controller (user input voltage from 0 to 30 volts).*

Connect a digital sc sensor

Note: *To connect an analog sensor, refer to the instructions supplied in the module or sensor manual.*

A digital sc sensor can be connected to the controller using the keyed quick-connect fitting (Figure 11). A digital sensor can be connected with the controller powered on or off.

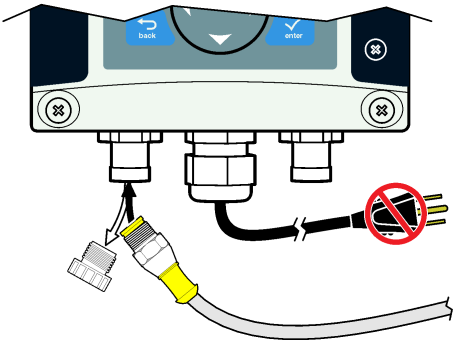
When a sensor is connected with the controller powered on, the controller does not automatically perform a device scan. To make the controller perform a device scan, navigate to the Test/Maintenance menu and select Scan Devices. If a new device is found, the controller performs the installation process without further user action.

When a sensor is connected with the controller powered off, the controller will perform a device scan when it is powered on again. If a new device is found, the controller performs the installation process without further user action.

Retain the connector cap to seal the connector opening in case the sensor must be removed.

Figure 11 Digital sensor quick connect

1.



Connect the optional digital communication output

The manufacturer supports Modbus RS485, Modbus RS232, Profibus DPV1 and HART communication protocols. The optional digital output module is installed in the location indicated by item 4 in Figure 7 on page 13. Refer to the instructions supplied with the network module for more details.

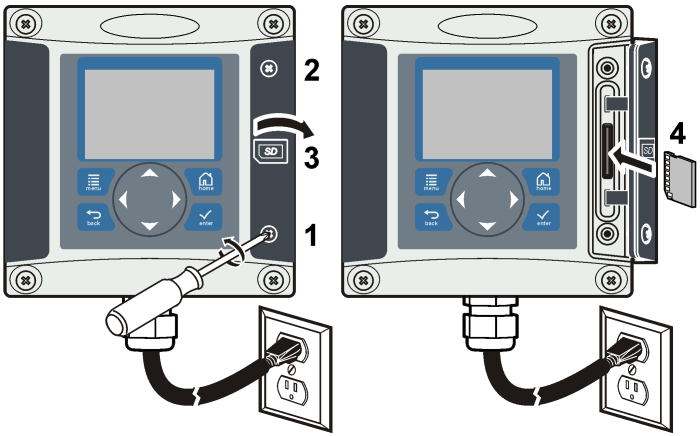
For information about Modbus registers, go to http://www.hach-lange.com or http://www.hach.com and search *Modbus registers* or go to any sc200 product page.

Install a Secure Digital (SD) memory card

For instructions on how to install an SD card in the controller, refer to Figure 12. Information on how to use the SD memory card can be found in the expanded version of this manual.

To remove an SD card, push down on the edge of the card and release, then pull the card up and out of the slot. After the card is removed, close the slot cover and tighten the cover screws.

Figure 12 SD card installation

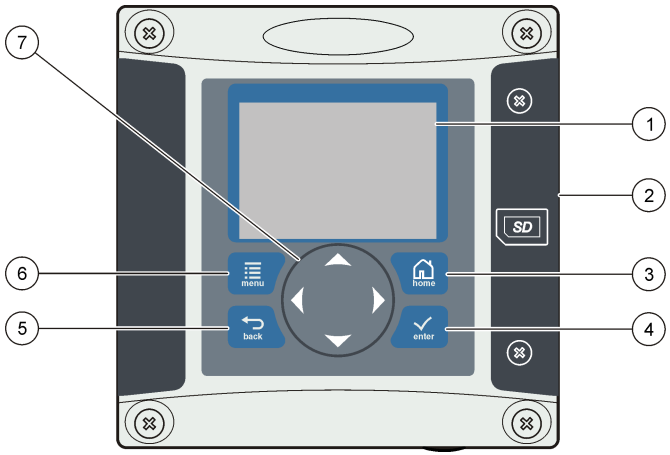


User interface and navigation

User interface

The keypad has four menu keys and four directional keys as shown in Figure 13.

Figure 13 Keypad and front panel overview



1 Instrument display	**5** **BACK** key. Moves back one level in the menu structure.
2 Cover for secure digital memory card slot	**6** **MENU** key. Moves to the Settings Menu from other screens and submenus.
3 **HOME** key. Moves to the Main Measurement screen from other screens and submenus.	**7** Directional keys. Used to navigate through the menus, change settings, and increment or decrement digits.
4 **ENTER** key. Accepts input values, updates, or displayed menu options.	

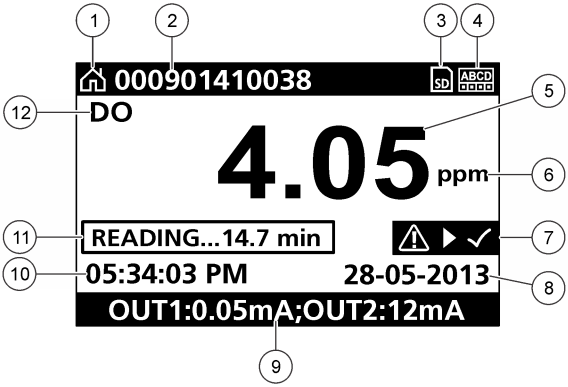
Inputs and outputs are set up and configured through the front panel using the keypad and display screen. This user interface is used to set up and configure inputs and outputs, create log information and calculated values, and calibrate sensors. The SD interface can be used to save logs and update software.

Display

Figure 14 shows an example of the main measurement screen with a DO sensor connected to the controller.

The front panel display screen shows sensor measurement data, calibration and configuration settings, errors, warnings and other information.

Figure 14 Example of Main Measurement screen



1 Home screen icon	**7** Warning status bar
2 Sensor name	**8** Date
3 SD Memory card icon	**9** Analog output values
4 Relay status indicator	**10** Time
5 Measurement value	**11** Progress bar
6 Measurement unit	**12** Measurement parameter

Table 5 Icon descriptions

Icon	Description
Home screen	The icon may vary depending on the screen or menu being displayed. For example, if an SD card is installed, an SD card icon appears here when the user is in the SD Card Setup menu.
SD memory card	This icon appears only if an SD card is in the reader slot. When a user is in the SD Card Setup menu, this icon appears in the upper left corner.
Warning	A warning icon consists of an exclamation point within a triangle. Warning icons appear on the right of the main display below the measurement value. Push the **ENTER** key then select the device to view any problems associated with that device. The warning icon will no longer be displayed once all problems have been corrected or acknowledged.
Error	An error icon consists of an exclamation point within a circle. When an error occurs, the error icon and the measurement screen flash alternately in the main display. To view errors, push the **MENU** key and select **Diagnostics**. Then select the device to view any problems associated with that device.

Additional display formats

- From the Main Measurement screen push the **UP** and **DOWN** arrow keys to switch between measurement parameters
- From the Main Measurement screen push the **RIGHT** arrow key to switch to a split display of up to 4 measurement parameters. Push the **RIGHT** arrow key to include additional measurements. Push the **LEFT** arrow key as needed to return to the Main Measurement screen
- From the Main Measurement screen push the **LEFT** arrow key to switch to the graphical display (see Graphical display on page 24 to define the parameters). Push the **UP** and **DOWN** arrow keys to switch measurement graphs

Graphical display

The graph shows concentration and temperature measurements for each channel in use. The graph supplies easy monitoring of trends and shows changes in the process.

1. From the graphical display screen use the up and down arrow keys to select a graph and push the **HOME** key.
2. Select an option:

Option	Description
MEASUREMENT VALUE	Set the measurement value for the selected channel. Select between Auto Scale and Manually Scale. For manual scaling enter the minimum and maximum measurement values
DATE & TIME RANGE	Select the date and time range from the available options

System startup

When initially powered up, the Language, Date Format and Date/Time screens appear in order. After these options are set, the controller performs a device scan and displays the message **Scanning for devices. Please wait...** If a new device is found, the controller performs an installation process before displaying a main measurement screen.

If the scan finds previously installed devices without configuration changes, the main measurement screen of the device in the number one position appears immediately after the scan is complete.

If a device has been removed from the controller or is not found during the next power-cycled or menu-driven scan, the controller displays a **Device missing** message and prompts to delete the missing device.

If no sensor is connected to an installed analog module, the controller will indicate an error. If devices are connected but not found by the controller, refer to Troubleshooting on page 26.

Set the language, date and time for the first time

The controller displays the language, date and time edit screens when the controller is powered on for the first time, and when it is powered on after the configuration settings have been set to their default values.
After the language, date and time options are set for the first time, update the options as necessary through the sc200 setup menu.

1. In the Language screen, highlight a language in the options list and push the **ENTER** key. English is the default language for the controller.
   The selected language is saved. The Date Format screen appears.
2. In the Date Format screen, highlight a format and push the **ENTER** key.
   The date and time format is saved. Next, the Date /Time screen appears.
3. In the Date/Time screen, push the **RIGHT** or **LEFT** arrow keys to highlight a field, then push the **UP** and **DOWN** arrow keys to update the value in the field. Update the other fields as necessary.
4. Push the **ENTER** key.
   The changes are saved and the controller performs a start-up scan for devices. If connected devices are found, the controller displays the main measurement screen for the device in the number one position. If the controller fails to find connected devices, refer to Troubleshooting on page 26.

Controller configuration information

General information about configuration options is listed in the table.

1. To navigate to the menu options, from the Settings Menu, select sc200 Setup.

Option	Description
Security setup	Sets the passcode preferences.
Output setup	Configures the controller analog outputs
Relay setup	Configures the controller relays

Option	Description
Display setup	Configures the controller display
Set Date/Time	Sets the controller time and date
Datalog setup	Configures data logging options. Available only if Calculation has been setup.
Manage Data	Select the device from the list of installed components to view the data or event log
Error Hold Mode	**Hold Outputs**—Holds outputs at last known value when controller loses communication with the sensor. **Transfer Outputs**—Switches to transfer mode when controller loses communication with the sensor. Outputs transfer to a pre-defined value.
Calculation	Configures the controller math function
sc200 Information	**S/W VER:**—Displays the current version of controller software **Bootloader VER:**—Displays the current Bootloader version. The Bootloader is a file that loads the main operating system for the controller **S/N:**—Displays the controller serial number **Version:**—Displays the current version of controller hardware
Discrete Input Setup	Configures three discrete input channels
Language	Assigns the language used in the controller

2. Select an option and push **ENTER** to activate the menu item.

Maintenance

⚠ CAUTION

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

Cleaning the controller

⚠ DANGER

Always remove power from the controller before performing maintenance activities.

Note: *Never use flammable or corrosive solvents to clean any part of the controller. Use of these solvents may degrade the environmental protection of the unit and may void the warranty.*

1. Make sure the controller cover is securely closed.
2. Wipe the controller exterior with a cloth dampened with water, or with a mixture of water and mild detergent.

Troubleshooting

Problem	Resolution
No current output	Verify current output configuration.
	Test current output signal using the Test/Maintenance submenu. Input a current value and verify the output signal at the controller connections.
	Contact Technical Support.

Problem	Resolution
Incorrect current output	Verify current output configuration.
	Test current output signal using the Test/Maintenance submenu. Input a current value and verify the output signal at the controller connections. If the output is incorrect, perform an output calibration.
No relay activation	Make sure relay connections are secure.
	If using an external power source, make sure the relay wiring is correct.
	Make sure the relay configuration is correct.
	Test the relay activation through the Test/Maintenance menu. The relay should energize and de-energize as selected.
	Make sure the controller is not in calibration mode and that the relay is not being held.
	Reset the Overfeed Timer to make sure the timer has not expired.
Secure Digital Memory (SD) card not recognized by the controller	Make sure the SD card is properly oriented. The copper traces should face toward the controller display.
	Make sure the SD card is fully seated in the slot and the spring lock is engaged.
	Make sure the SD card is properly formatted with a Fat 32 format. The MMC format is not supported. Follow the instructions of the card manufacturer to format the SD card on a PC.
	Make sure the card is not larger than 32 GB.
	Make sure an SD card is being used. Other types of cards (such as xSD, micro SD, mini SD) will not work properly.
Information not saving, or not saving properly to the SD card.	Make sure the SD card is properly formatted with the FAT 32 format. The MMC format is not supported. Follow the instructions of the card manufacturer to format the SD card on a PC.
	If the SD card has previously been in use, format the card with the Fat 32 format, install the card in the controller, and try downloading files.
	Try a different SD card.
SD card full	Read the SD card with a PC or other card reader device. Save important files and then delete some or all of the files on the SD card.
Controller cannot find software updates on the SD card.	Make sure an appropriate folder is created by installing the SD card in the controller. An update folder will automatically be created.
	Install the SD card on a PC and make sure the software files are located in the appropriate update folder.
	If the same SD card is used with multiple controllers, each controller will have a separate folder on the system. Make sure the software updates are in the folder dedicated to the controller in use.

Problem	Resolution
Display is lit but shows no characters or characters are faint or blurry.	Adjust the display contrast
	Make sure protective film has been removed from display.
	Clean the outside of the controller, including the display screen.
Controller will not power up, or powers up intermittently	Make sure the AC power connections are properly terminated in the controller.
	Make sure the power strip, line power, wall plug are all properly plugged in.
	Contact Technical Support
Network or sensor module not recognized	Make sure the module is properly installed.
	Make sure the module selector switch is set to the proper number.
	Remove sensor module and install the module into the second analog slot. Apply power to the controller and allow the controller to perform a device scan.
	Contact Technical Support.
Sensor not recognized ***Note:*** *Example of possible display message:* ****	If the sensor is an analog sensor and a corresponding module is installed in the controller, refer to the instructions supplied with the Network or Sensor Module.
	Make sure the digital connector wiring harness is seated on the inside of the door assembly and that the wiring harness is not damaged.
	If the digital sensor is connected to the controller with a digital termination box, user supplied junction box, digital extension cables, or a user-supplied extension cable, connect the sensor directly to the controller and perform a device scan. If the controller recognizes the sensor, check that all the wiring in the junction boxes or extension cables is correct.
	Make sure that only two sensors are installed in the controller. Although two analog module ports are available, if a digital sensor and two analog modules are installed, only two of the three devices will be seen by the controller.
	Contact Technical Support
Device Missing error message appears	Perform a Device Scan from the Test/Maintenance menu.
	Power cycle the controller

Catalog Number 6120218

pHD sc Digital Differential pH/ORP Sensors

USER MANUAL

October 2006, Edition 4

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eac/te/dp

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Section 1 Specifications

Specifications are subject to change without notice.

Table 1 Differential pH and ORP Sensor Specifications

Specification Category	pH Sensors[1]	Stainless Steel pH Sensor	ORP Sensors[2]
Wetted Materials	PEEK®[3] or Ryton®[4] (PVDF) body, salt bridge of matching material with Kynar®[5] junction, glass process electrode, titanium ground electrode, and Viton®[6] O-ring seals (pH sensor with optional HF-resistant glass process electrode has 316 stainless steel ground electrode, and perfluoroelastomer wetted O-rings; for other wetted O-ring materials consult the manufacturer)	Immersion mounting only, 316 SS Stainless Steel body with Ryton® (PVDF) ends and salt bridge.	PEEK® or Ryton® (PVDF) body, salt bridge of matching material with Kynar® junction, glass and platinum (or glass and gold) process electrode, titanium ground electrode, and Viton® O-ring seals
Operating Temperature Range	–5 to 70 °C (23 to 158 °F) for sensor with integral digital electronics –5 to 105 °C (23 to 221 °F) for analog sensor with digital gateway	0 to 50 °C (32 to 122 °F) for sensor with integral digital electronics	–5 to 70 °C (23 to 158 °F) for sensor with integral digital electronics –5 to 105 °C (23 to 221 °F) for analog sensor with digital gateway
Pressure/Temperature Limits (without mounting hardware)	6.9 bar at 105 °C (100 psi at 221 °F) for analog with gateway 6.9 bar at 70 °C (100 psi at 158 °F)	N/A (immersion only)	6.9 bar at 70 °C (100 psi at 158 °F) 6.9 bar at 105 °C (100 psi at 221 °F) for analog with gateway
Maximum Flow Rate	3 m (10 ft) per second	3 m (10 ft) per second	3 m (10 ft) per second
Built-in Temperature Element	NTC 300 ohm thermistor for automatic temperature compensation and analyzer temperature readout	NTC 300 ohm thermistor for automatic temperature compensation and analyzer temperature readout	NTC 300 ohm thermistor for analyzer temperature readout only — not for automatic temperature compensation
Stability	0.03 pH per 24 hours, non-cumulative	0.03 pH per 24 hours, non-cumulative	2 mV per 24 hours, non-cumulative
Maximum Transmission Distance	1000 m (3280 ft) with termination box	1000 m (3280 ft) with termination box	1000 m (3280 ft) with termination box
Sensor Cable (integral)	Digital: PUR (polyurethane) 4-conductor with one shield, rated to 105 °C (221 °F), 10 m (33 ft) standard length Analog: Five-conductor (plus two isolated shields) cable with XLPE (cross-linked polyethylene) jacket; rated to 150 °C (302 °F); 6 m (20 ft) standard length	Digital: PUR (polyurethane) 4-conductor with one shield, rated to 105 °C (221 °F), 10 m (33 ft) standard length	Digital: PUR (polyurethane) 4-conductor with one shield, rated to 105 °C (221 °F), 10 m (33 ft) standard length Analog: Five-conductor (plus two isolated shields) cable with XLPE (cross-linked polyethylene) jacket; rated to 150 °C (302 °F); 6 m (20 ft) standard length
Components	Corrosion-resistant materials, fully-immersible probe with 10 m (30 ft) cable	Corrosion-resistant materials, fully-immersible probe with 10 m (30 ft) cable	Corrosion-resistant materials, fully-immersible probe with 10 m (30 ft) cable
Measuring Range	–2.0 to 14.0 pH or –2.00 to 14.00 pH	–2.0 to 14.0 pH or –2.00 to 14.00 pH	–1500 to +1500 mV
Probe Storage Temperature	4 to 70 °C (40 to 158 °F); 0 to 95% relative humidity, non-condensing	4 to 70 °C (40 to 158 °F); 0 to 95% relative humidity, non-condensing	4 to 70 °C (40 to 158 °F); 0 to 95% relative humidity, non-condensing

Table 1 Differential pH and ORP Sensor Specifications (continued)

Specification Category	pH Sensors[1]	Stainless Steel pH Sensor	ORP Sensors[2]
Temperature Compensation	Automatic from –10 to 105 °C (14.0 to 221 °F) with selection for NTC 300 ohm thermistor, Pt 1000 ohm RTD, or Pt 100 ohm RTD temperature element, or manually fixed at a user-entered temperature; additional selectable temperature correction factors (ammonia, morpholine, or user-defined pH/°C linear slope) available for pure water automatic compensation from 0.0 to 50 °C (32 to 122 °F)	Automatic from –10 to 105 °C (14.0 to 221 °F) with selection for NTC 300 ohm thermistor, Pt 1000 ohm RTD, or Pt 100 ohm RTD temperature element, or manually fixed at a user-entered temperature; additional selectable temperature correction factors (ammonia, morpholine, or user-defined pH/°C linear slope) available for pure water automatic compensation from 0.0 to 50 °C (32 to 122 °F)	N/A
Measurement Accuracy	±0.02 pH	±0.02 pH	±5 mV
Temperature Accuracy	±0.5 °C (0.9 °F)	±0.5 °C (0.9 °F)	±0.5 °C (0.9 °F)
Repeatability	±0.05 pH	±0.05 pH	±2mV
Sensitivity	±0.01 pH	±0.01 pH	±0.5 mV
Calibration Methods	Two point automatic, one point automatic, two point manual, one point manual.	Two point automatic, one point automatic, two point manual, one point manual.	one point manual
Maximum Probe Immersion Depth/ Pressure	Submersible to 107 m (350 ft)/1050 kPa (150 psi)	Immersion only	Submersible to 107 m (350 ft)/1050 kPa (150 psi)
Sensor Interface	Modbus	Modbus	Modbus
Probe Cable Length	6 m (20 ft) + 7.7 m (25 ft) interconnect cable extension for analog sensor with digital gateway 10 m (31 ft) for sensor with integral digital electronics	6 m (20 ft) + 7.7 m (25 ft) interconnect cable extension for analog sensor with digital gateway 10 m (31 ft) for sensor with integral digital electronics	6 m (20 ft) + 7.7 m (25 ft) interconnect cable extension for analog sensor with digital gateway 10 m (31 ft) for sensor with integral digital electronics
Probe Weight	316 g (11 oz)	870 g (31 oz)	316 g (11 oz)
Probe Dimensions	See Figure 2 on page 9 through Figure 3 on page 9.	See Figure 4 on page 9.	See Figure 2 on page 9 through Figure 3 on page 9.

[1] Most pH applications are in the 2.5 to 12.5 pH range. The pHD™ Differential pH sensor with the wide-range glass process electrode performs exceptionally well in this range. Some industrial applications require accurate measurement and control below 2 or above 12 pH. In these special cases, please contact the manufacturer for further details.

[2] For best ORP measuring results in solutions containing zinc, cyanide, cadmium or nickel, the manufacturer recommends using the pHD™ ORP sensor equipped with a gold electrode.

[3] PEEK® is a registered trademark of ICI Americas, Inc.

[4] Ryton® is a registered trademark of Phillips 66 Co.

[5] Kynar® is a registered trademark of Pennwalt Corp.

[6] Viton® is a registered trademark of E.I. DuPont de Nemours + Co.

Table 2 Digital Gateway Specifications

Weight	145 g (5 oz)
Dimensions	17.5 x 3.4 cm (7 x 1 3/8 in.)
Operating Temperature	–20 to 60 °C (–4 to 140°F)

Section 2 General Information

2.1 Safety Information

Please read this entire manual before unpacking, setting up, or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure that the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that specified in this manual.

This product is acceptable for use in a Hazardous Location when used with an sc100 Controller and installed per Control Drawing 58600-78 as described in the sc100 Controller Manual, Cat. No. 5860018.

2.1.1 Use of Hazard Information

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

Important Note: *Information that requires special emphasis.*

Note: *Information that supplements points in the main text.*

2.1.2 Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
	This symbol, when noted on a product enclosure or barrier, indicates that a risk of electrical shock and/or electrocution exists.
	This symbol, if noted on the product, indicates the need for protective eye wear.
	This symbol, when noted on the product, identifies the location of the connection for Protective Earth (ground).
	This symbol, when noted on the product, identifies the location of a fuse or current limiting device.

2.2 General Sensor Information

Optional equipment, such as mounting hardware for the probe, is supplied with instructions for all user installation tasks. Several mounting options are available, allowing the probe to be adapted for use in many different applications.

The electronics of the sensor are encapsulated in a PEEK® or Ryton® body. The pH sensor has an integral NTC 300 ohm thermistor to automatically compensate pH readings for temperature changes. ORP sensors have a fixed temperature value of 25 °C/300 ohm (the ORP measurement is not temperature dependent).

2.2.1 Sensor Body Styles

pHD™ Differential pH and ORP sensors are available in three body styles:

- **Convertible Body Style** — has 1-inch NPT threads at both ends of the body for mounting in any of the following configurations:
  - into a standard 1-inch NPT pipe tee
  - into a pipe adapter for union mounting with a standard 1-½ inch pipe tee
  - onto the end of a pipe for immersion into a vessel

Note: *The convertible style sensor can also be retrofitted into existing installations for 1-½ inch LCP, Ryton, and epoxy sensors.*

- **Insertion Body Style** — similar to the convertible sensor except that its 1-inch NPT threads are only on the cable end for mounting into a flow cell or the pipe adapter of a ball valve hardware assembly. This hardware enables the sensor to be inserted into or retracted from the process without stopping the process flow.
- **Sanitary Body Style** — features a built-in 2-inch flange for mounting into a 2-inch sanitary tee. Included with the sanitary-style sensor is a special cap and EDPM compound gasket for use with the sanitary hardware.

In addition, all probes are available with or without integral digital electronics. For applications with extreme temperatures, the sensor without integral digital electronics can be combined with the digital gateway.

Figure 1 Convertible Style Sensor Dimensions

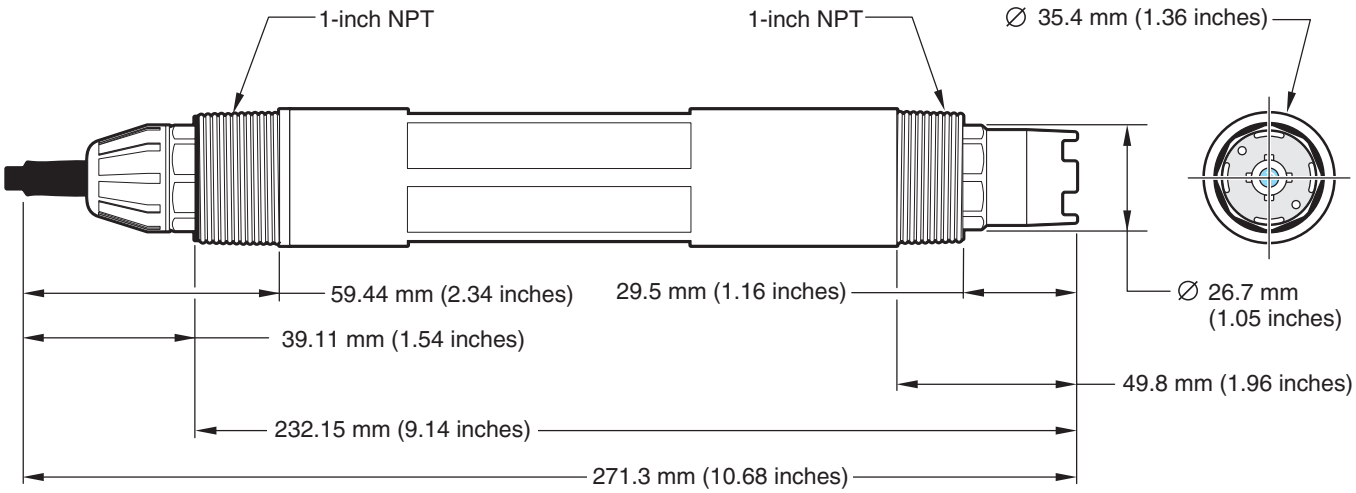


Figure 2 Insertion Style Sensor Dimensions

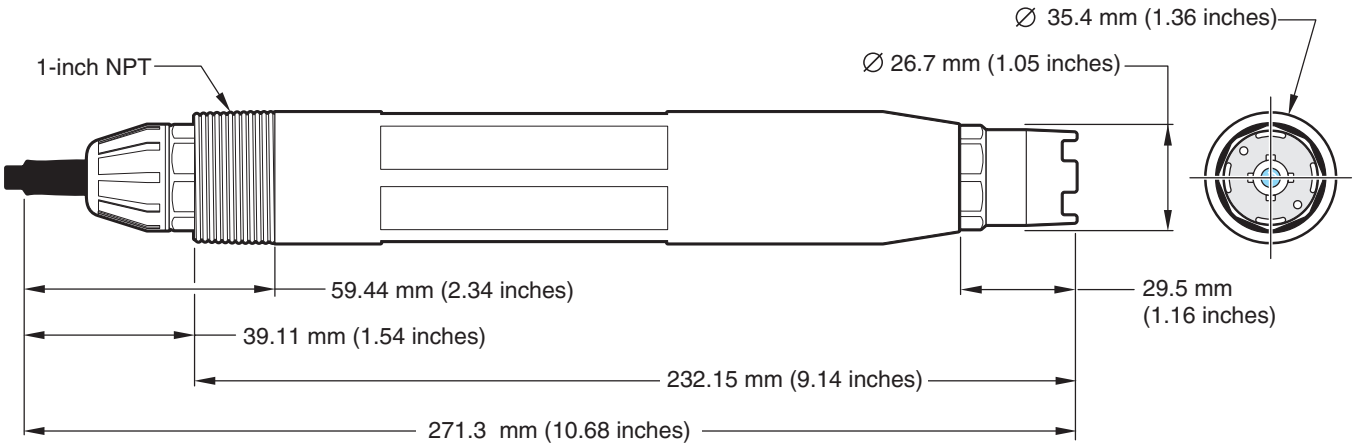


Figure 3 Sanitary Style Sensor Dimensions

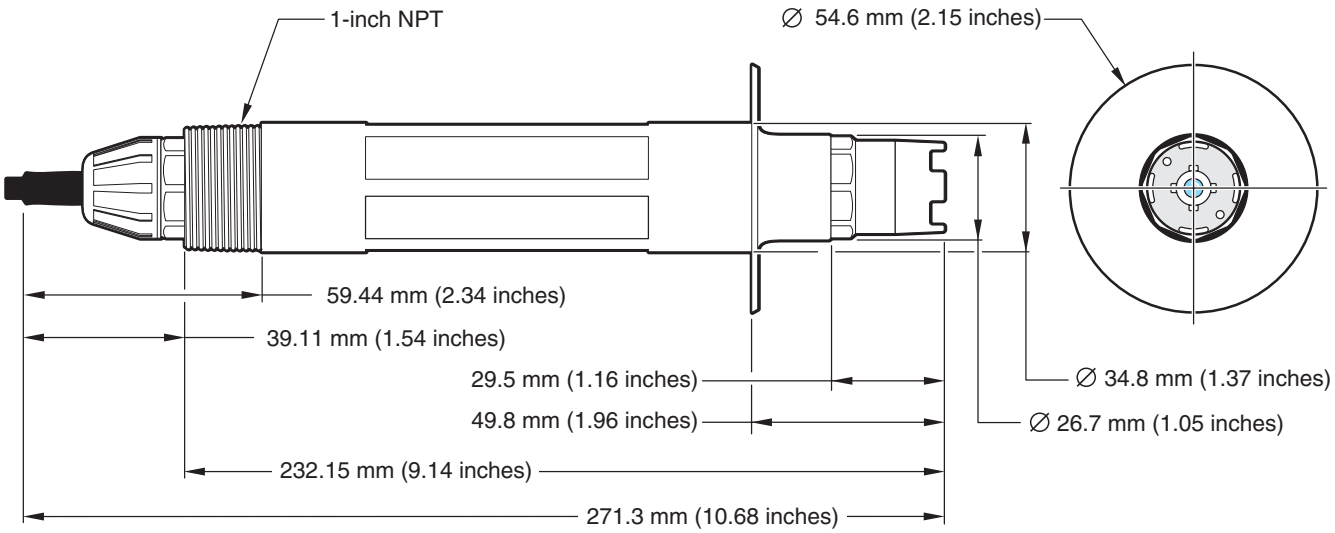
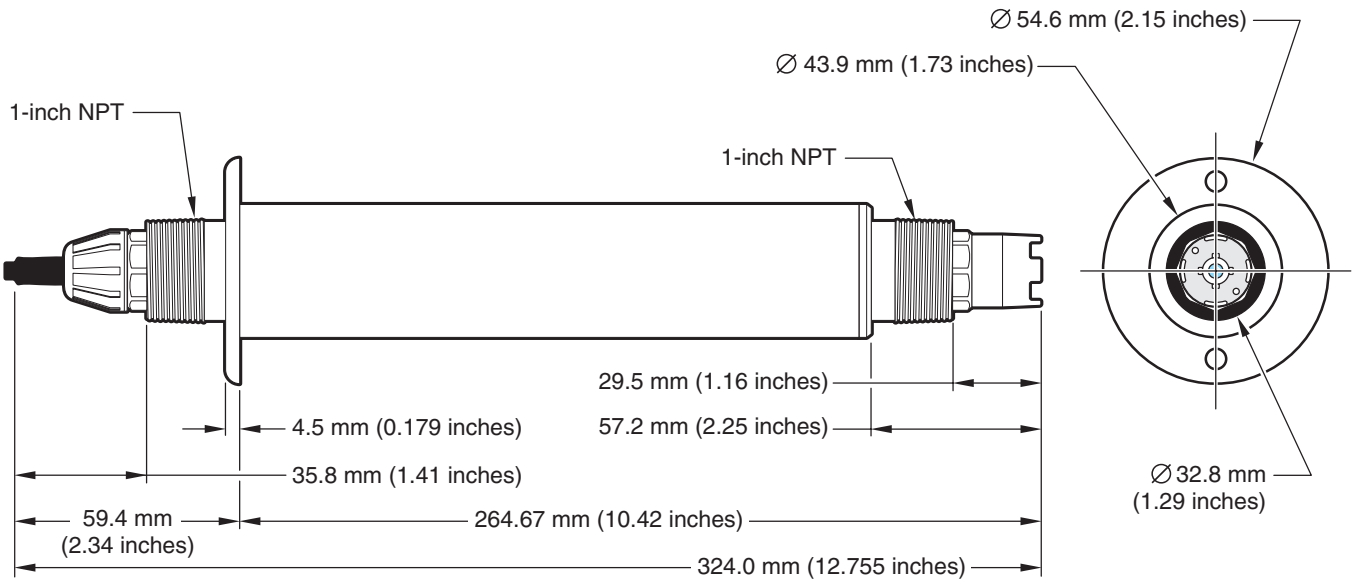

1-inch NPT
∅ 54.6 mm (2.15 inches)
59.44 mm (2.34 inches)
39.11 mm (1.54 inches)
29.5 mm (1.16 inches)
∅ 34.8 mm (1.37 inches)
49.8 mm (1.96 inches)
∅ 26.7 mm (1.05 inches)
232.15 mm (9.14 inches)
271.3 mm (10.68 inches)

Figure 4 Stainless Steel Style Sensor (DPS1 and DRS5) Dimensions



2.3 The Digital Gateway

The digital gateway was developed to provide a means to use existing analog sensors with the new digital controllers. The gateway contains all the necessary software to interface with the controller and output a digital signal. Extension cables are required for connection from the digital gateway to the digital controller. See Replacement Parts and Accessories on page 39.

2.4 Operating Precaution

CAUTION
If the pH process electrode breaks, handle the sensor very carefully to prevent injury.

Before placing the pH or ORP sensor into operation, remove the protective cap to expose the process electrode and salt bridge. Save the protective cap for future use.

For short-term storage (when sensor is out of the process for more than one hour) fill the protective cap with pH 4 buffer or DI water and place the cap back on the sensor. Keeping the process electrode and salt bridge moist will avoid slow response when the sensor is placed back in operation.

For extended storage, repeat the short-term storage procedure every 2 to 4 weeks, depending on the surrounding environmental conditions. See Specifications on page 5 for temperature storage limits.

The process electrode at the tip of the pH sensor has a glass bulb, which can be broken. Do not subject it to abrupt impact or other mechanical abuse.

The gold or platinum process electrode at the ORP sensor tip has a glass shank (hidden by the salt bridge) which can break. Do not subject this electrode to impact or other mechanical abuse.

DANGER
Only qualified personnel should conduct the tasks described in this section of the manual.

DANGER
Seul un technicien qualifié peut effectuer les tâches d'installation décrites dans cette section du manuel.

3.1 Connecting/Wiring the Sensor to the sc100 Controller

DANGER
The sc100 and certain versions of the sensor are suitable for use in Class 1, Division 2, Groups A, B, C, D Hazardous Locations . See Control Drawing 58600-78 in the sc100 Controller Manual, Cat. No. 58600-18 for acceptable sensor versions and installation requirements.

DANGER
Le sc100 et certaines versions du capteur peuvent être utilisés dans des endroits dangereux de la Classe 1, Division 2, Groupes A, B, C, D. Reportez-vous au schéma de contrôle 58600-78 du Manuel du contrôleur sc100, Réf. 58600-18 pour connaître les versions des capteurs admises et les conditions d'installation.

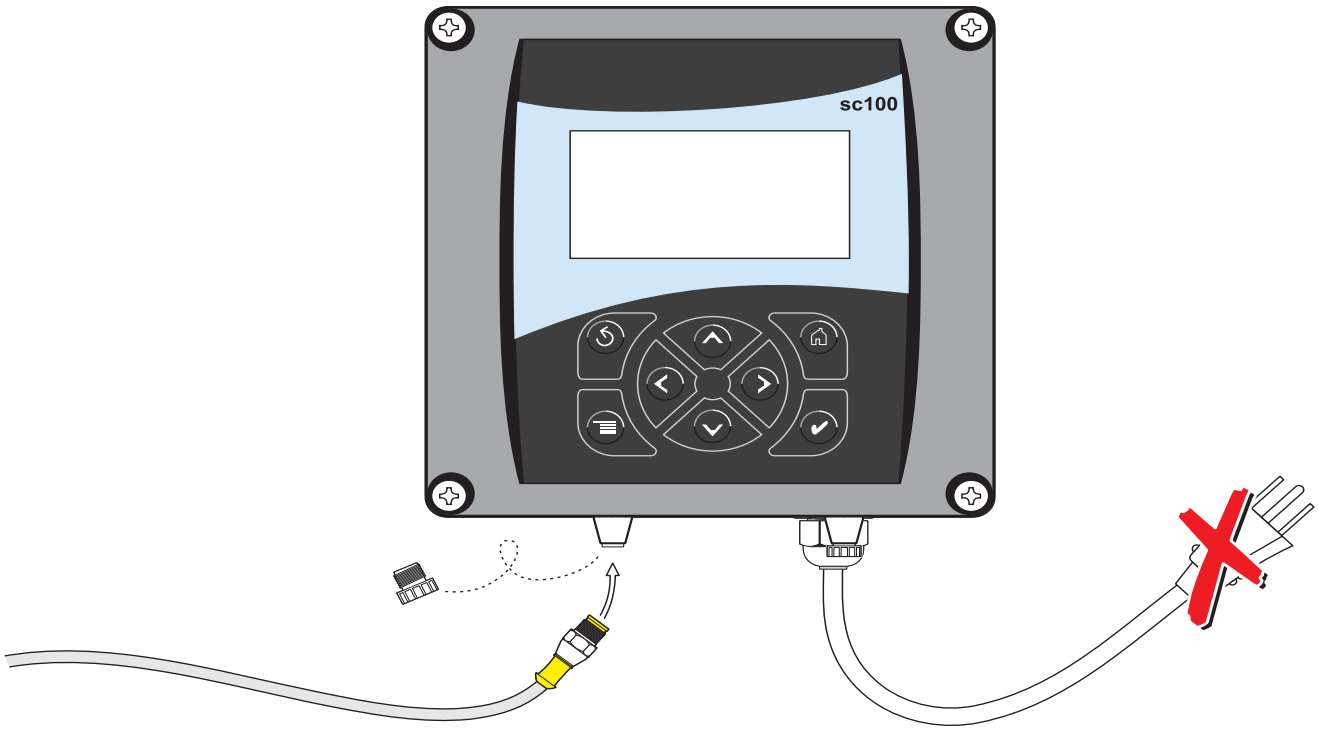
3.1.1 Connecting the sc Sensor to a sc100 Controller in a Non-hazardous Location

3.1.1.1 Attaching a sc Sensor with a Quick-connect Fitting

Important Note: *The standard quick-connect fitting is NOT suitable for Class 1, Division 2 Hazardous Location installations without the connector lock installed, see section 3.1.2 on page 13 for more information.*

The sensor has a keyed quick-connect fitting for easy attachment to the controller (Figure 5). Retain the connector cap to seal the connector opening when the sensor is removed. Extension cables may be purchased to extend the sensor cable length. If the total cable length exceeds 100 m (300 ft), a termination box must be installed. See Replacement Parts and Accessories on page 39.

Figure 5 Attaching the Sensor using the Quick-connect Fitting



3.1.1.2 Hard-wiring a sc Sensor to the Controller

Important Note: *Hard-wiring the sensor to the sc100 is not an approved method for Class I, Division 2 Hazardous Locations.*

1. Disconnect power to the controller if powered.
2. Open the controller cover.
3. Disconnect and remove the existing wires between the quick-connect and terminal strip J5, see Figure 5 on page 12.
4. Remove the quick-connect fitting and wires and install the threaded plug on the opening to maintain the environmental rating.
5. Cut the connector from the sensor cable.
6. Strip the insulation on the cable back 1-inch. Strip ¼-inch of each individual wire end.
7. Pass the cable through conduit and a conduit hub or a strain relief fitting (Cat.No.16664) and an available access hole in the controller enclosure. Tighten the fitting.

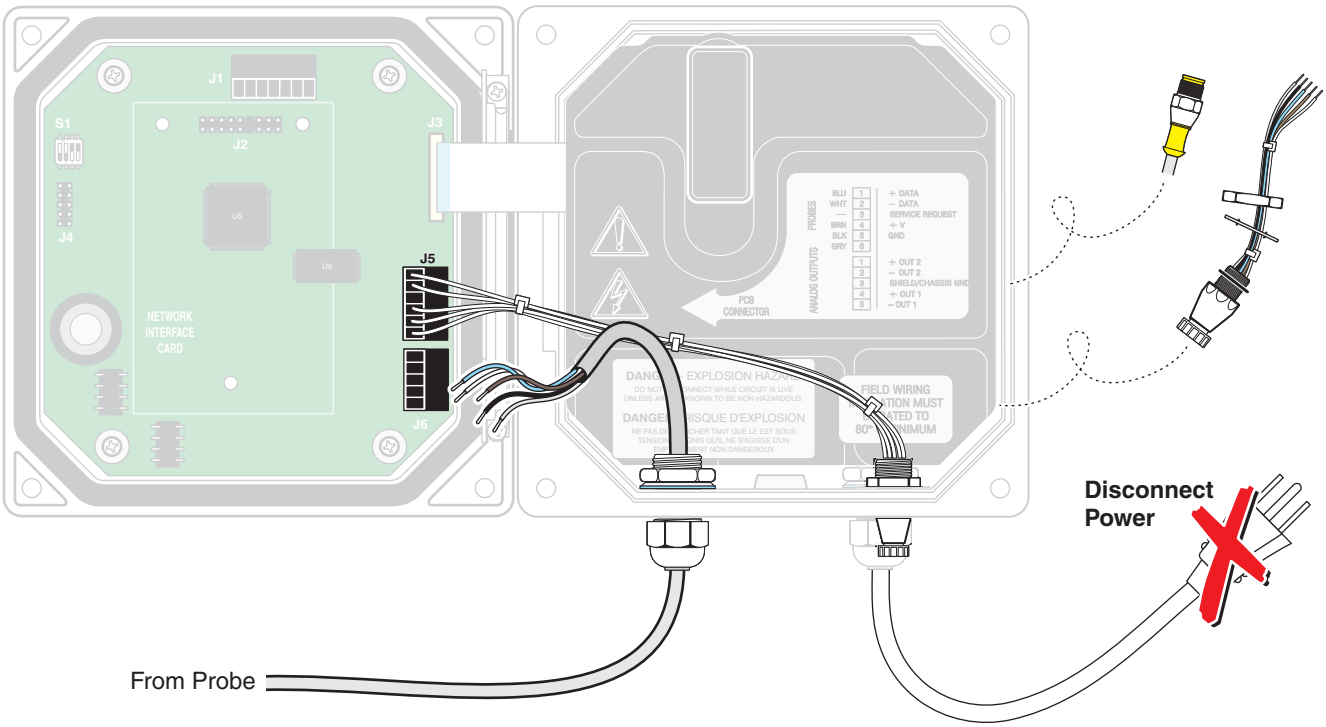
Note: *Use of strain relief fitting other than Cat. No. 16664 may result in a hazard. Use only the recommended strain relief fitting.*

8. Reinstall the plug on the sensor access opening to maintain the environmental rating.
9. Wire as shown in Table 3 and Figure 6.
10. Close and secure the cover.

Table 3 Wiring the Sensor at Terminal Block J5

Terminal Number	Terminal Designation	Wire Color
1	Data (+)	Blue
2	Data (–)	White
3	Service Request	No Connection
4	+12 V dc	Brown
5	Circuit Common	Black
6	Shield	Shield (grey wire in existing quick disconnect fitting)

Figure 6 Hard-wiring the sensor



3.1.2 Connecting the sc Sensor to a sc100 Controller in a Hazardous Location

DANGER
The sc100 and certain versions of the sensor are suitable for use in Class 1, Division 2, Groups A, B, C, D Hazardous Locations. See Control Drawing 58600-78 in the sc100 Controller Manual, Cat. No. 58600-18 for acceptable sensor versions and installation requirements.

DANGER
Le sc100 et certaines versions du capteur peuvent être utilisés dans des endroits dangereux de la Classe 1, Division 2, Groupes A, B, C, D. Reportez-vous au schéma de contrôle 58600-78 du Manuel du contrôleur sc100, Réf. 58600-18 pour connaître les versions des capteurs admises et les conditions d'installation.

DANGER
Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

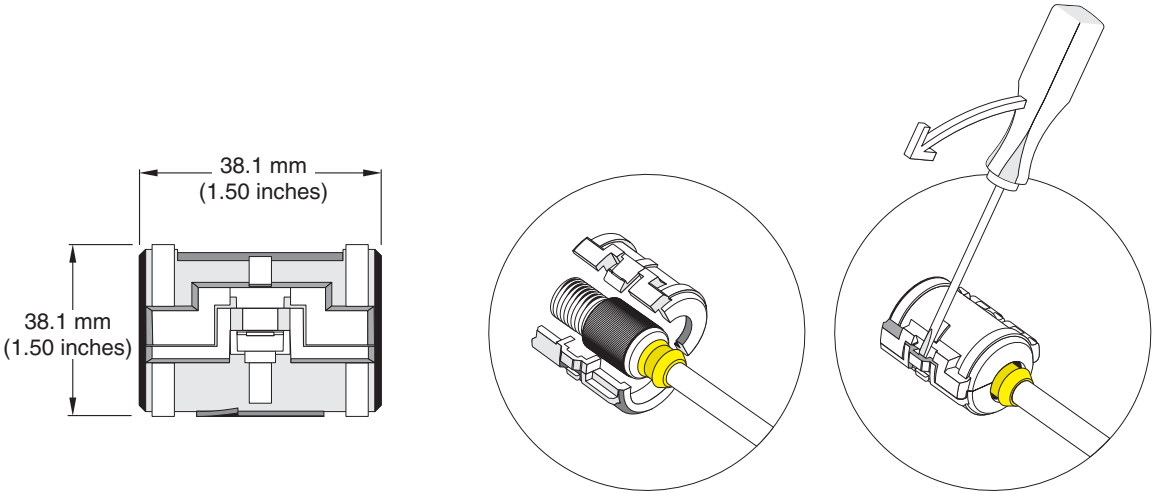
DANGER
Risque d'explosion. Couper le courant ou s'assurer que l'emplacement est designe non dangereux avant de replacer le aucon composant.

3.1.2.1 Attaching a sc Sensor with a Quick-connect Fitting in a Hazardous Location

The sensor cable is supplied with a keyed quick-connect fitting for easy attachment to the controller, see Figure 5. For hazardous locations, a connector safety lock (Cat. No. 6139900) **must** be installed. Retain the connector cap to seal the connector opening in case the sensor must be removed.

1. Remove the connector cap from sc100 controller. Retain the connector cap to seal the connector opening in case the sensor must be removed.
2. Connect the sensor connector to the plug on the sc100.
3. Install a connector safety lock (Figure 7). Align the lock over the connector and squeeze the two halves together to lock. To remove the connector safety lock by inserting a small flat-bladed screwdriver into the locking groove. Pivot the screwdriver away from the groove and separate the two halves (Figure 7).

Figure 7 Installing the Connector Safety Lock



3.2 Connecting the Sensor to the sc1000

3.2.1 Connecting the Sensor using the Quick-connect Fittings

1. Unscrew the connector cap from the controller. Retain the connector cap to seal the connector opening in case the sensor must be removed.
2. Push the connector into the socket.
3. Hand-tighten the union nut.

Note: *Do not use the middle connection for the sensors as this is reserved for the display module.*

3.3 Using the Digital Gateway

The digital gateway is designed to provide a digital interface to the controller. The non-sensor end is wired to the sc100 or sc1000 controller in a non-hazardous location as shown in section 3.1.1 on page 11. The non-sensor end is wired to the sc100 controller in a hazardous location as shown in section 3.1.2 on page 13.

3.3.1 Wiring the Digital Gateway

DANGER
The sc100 and certain versions of the sensor are suitable for use in Class 1, Division 2, Groups A, B, C, D Hazardous Locations . See Control Drawing 58600-78 in the sc100 Controller Manual, Cat. No. 58600-18 for acceptable sensor versions and installation requirements.

DANGER
Le sc100 et certaines versions du capteur peuvent être utilisés dans des endroits dangereux de la Classe 1, Division 2, Groupes A, B, C, D. Reportez-vous au schéma de contrôle 58600-78 du Manuel du contrôleur sc100, Réf. 58600-18 pour connaître les versions des capteurs admises et les conditions d'installation.

DANGER
Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

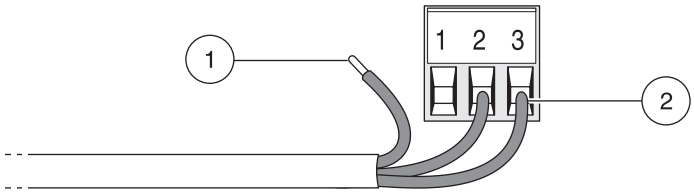
DANGER
Risque d'explosion. Couper le courant ou s'assurer que l'emplacement est designe non dangereux avant de replacer le aucon composant.

1. Route the cable from the sensor through the strain relief in the digital gateway then properly terminate the wire ends (see Figure 8).

Note: *Do not tighten the strain relief until the digital gateway is wired and the two halves are threaded securely together.*

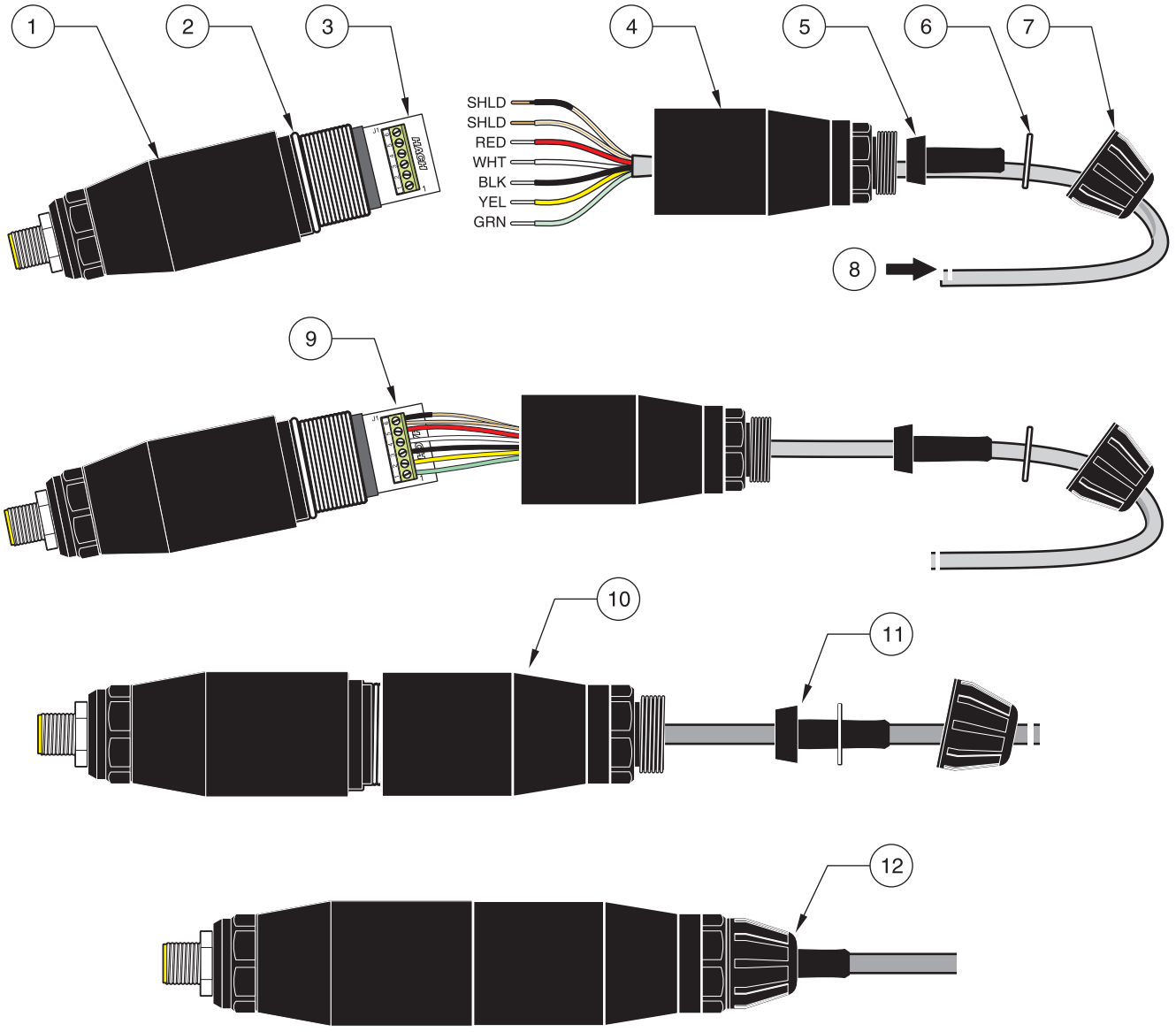
2. Insert the wires as shown in Table 4 and Figure 9.
3. Make sure the O-ring is properly installed between the two halves of the digital gateway and thread the two halves together. Hand tighten.
4. Tighten the strain relief to secure the sensor cable.
5. Connect the digital gateway to the controller.
   - sc100 Non-Hazardous Location Instructions—section 3.1.1 on page 11.
   - sc100 Hazardous Location Instructions—section 3.1.2 on page 13g
   - sc1000 Connection Instructions—Refer to section 3.2 on page 14.

Figure 8 Proper Wire Preparation and Insertion



1. Strip ¼-inch of insulation.	**2.** Seat insulation against connector with no bare wire exposed.

Figure 9 Wiring and Assembling the Digital Gateway



1. Digital gateway front	**7.** Cord grip
2. O-ring	**8.** From sensor
3. Sensor wire connector	**9.** Insert wires into connector according to Table 4. Use the included 2 mm screwdriver (Cat. No. 6134300) to secure connections.
4. Digital gateway back	**10.** Screw back of digital gateway onto front.
5. Cable bushing	**11.** Push cable bushing and anti-rotation washer into back.
6. Anti-rotation washer	**12.** Fasten cord grip securely. Assembly is complete.

Table 4 Wiring the Digital Gateway (Cat. No. 6120500)

Sensor (wire color)	Sensor Signal	Digital Gateway J1
Green	Ref	J1-1
Yellow	Temp +	J1-2
Black	Temp –	J1-3
White	VI	J1-4
Red	Active	J1-5
Clear	Shield	J1-6
Clear w/shrink wrap	Shield	J1-6

3.3.2 Mounting the Digital Gateway

The digital gateway is supplied with a mounting clip for mounting to a wall or other flat surface. See Figure 10 for dimensions. Use an appropriate fastener to secure it to the wall, see Figure 11. After the sensor is wired to the digital gateway and the two halves are threaded together, place the mounting clip over the center of the digital gateway and squeeze the clip together to secure.

Figure 10 Digital Gateway Dimensions

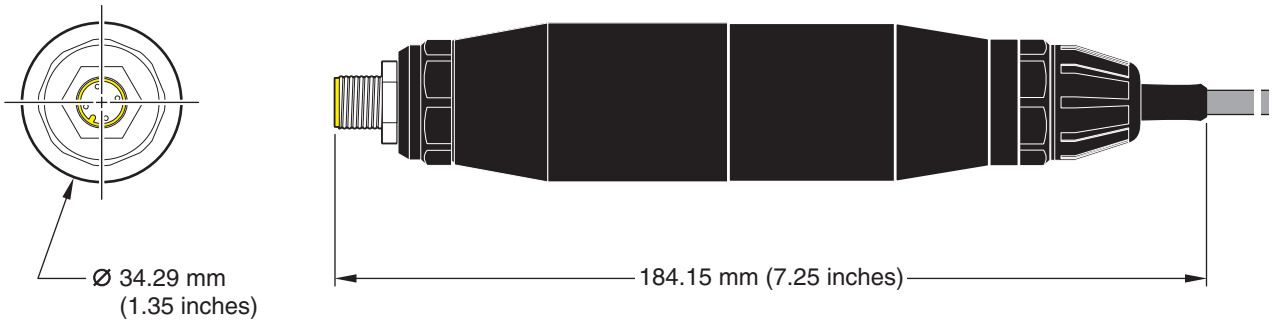
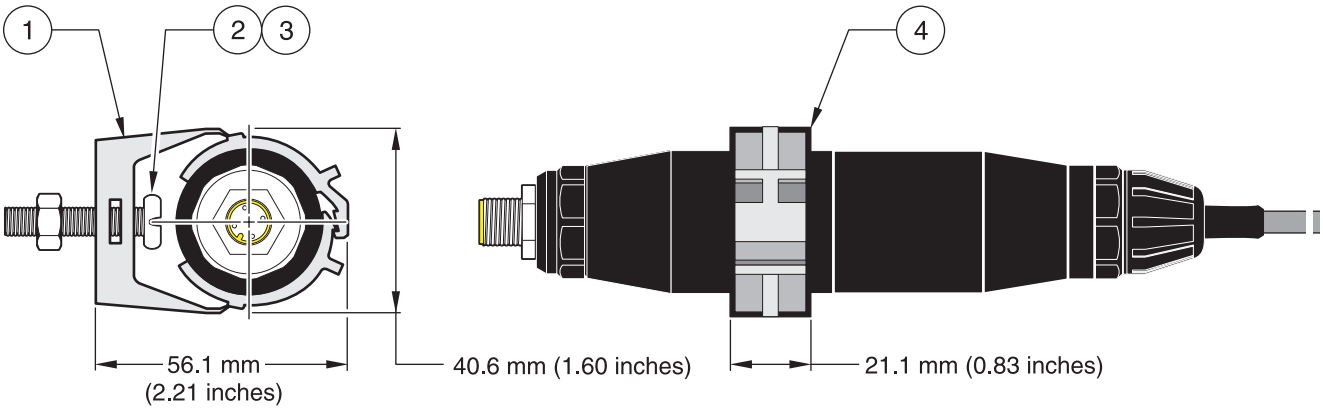


Figure 11 Mounting the Digital Gateway

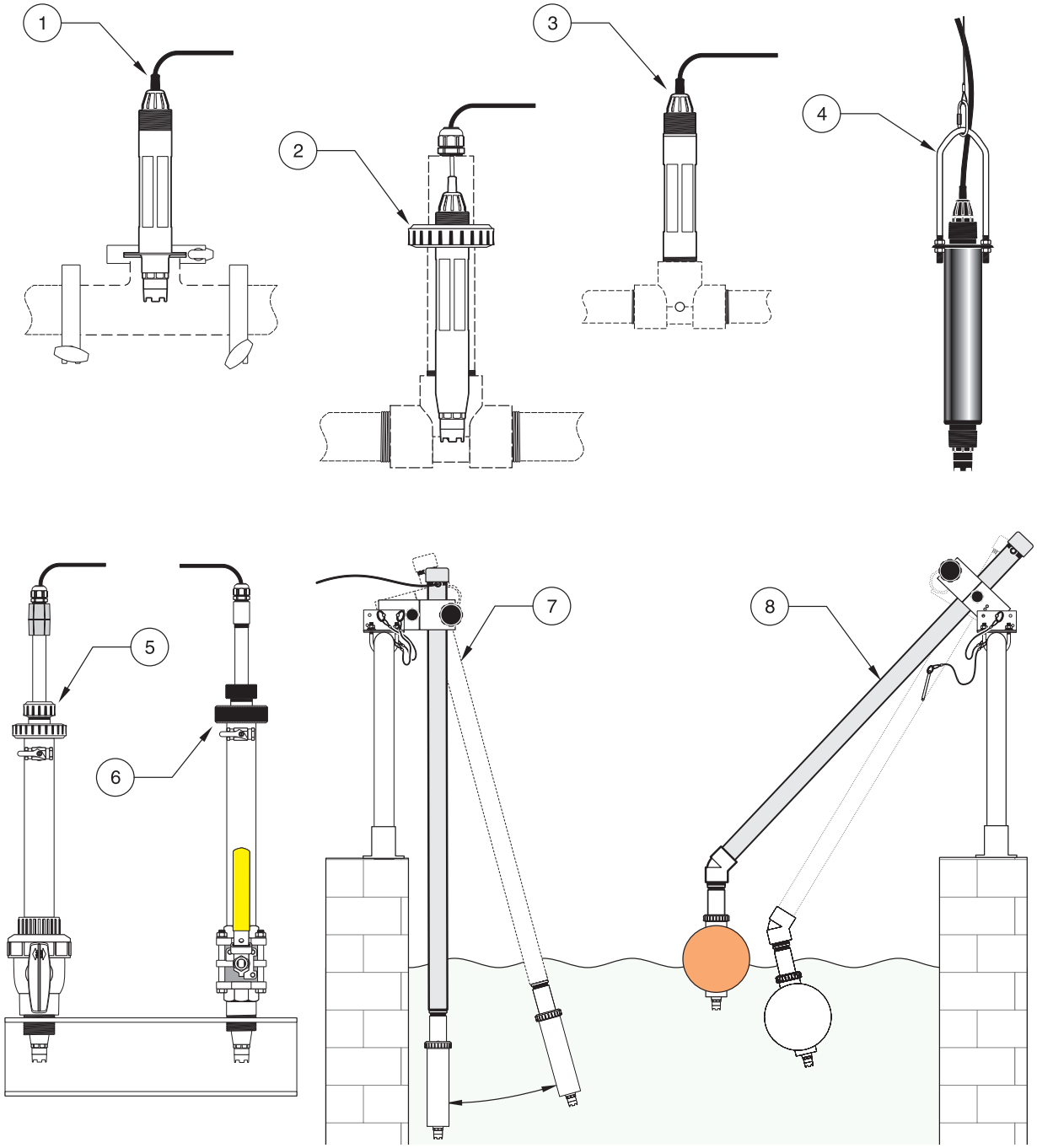


1.	Mounting Clip	**3.**	Hex Nut, ¼-28
2.	Screw, pan head, ¼-28 x 1.25-in.	**4.**	Mount clip, insert digital gateway, squeeze clip closed.

3.4 Installing the Sensor in the Sample Stream

- Install the sensor so the sample contacts is representative of the entire process.
- Mount the sensor at least 508 mm (20 in) from the aeration basin wall, and immerse it at least 508 mm (20 in) into the process.
- Install the sensor using the instructions supplied with the installation apparatus. See Figure 12 for suggested mounting configurations.

Figure 12 Sensor Installation Examples

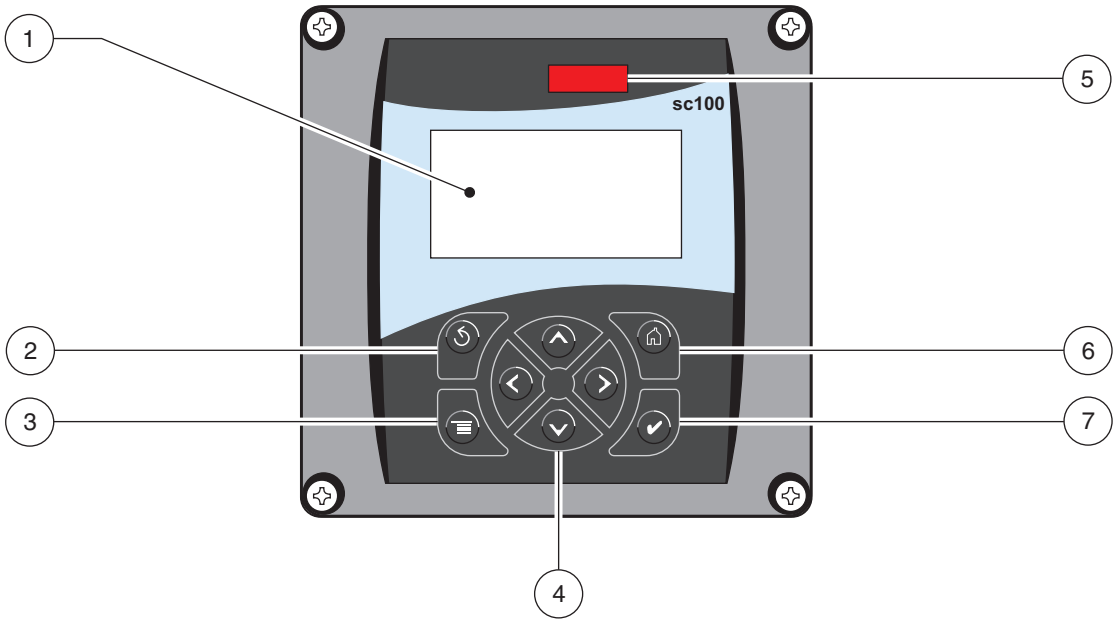


1.	Sanitary mount	**5.**	PVC Insertion mount
2.	Union mount	**6.**	Stainless steel insertion mount
3.	Flow-through mount	**7.**	Immersion mount
4.	Hanging stainless steel sensor with the bale	**8.**	Immersion mount, ball float

4.1 Using the sc100 Controller

The front of the controller is shown in Figure 13. The keypad consists of the eight keys described in Table 5.

Figure 13 Front of the Controller



1. Instrument display	**5.** IrDA window
2. **BACK** key	**6.** **HOME** key
3. **MENU** key	**7.** **ENTER** key
4. **RIGHT**, **LEFT**, **UP**, and **DOWN** keys	

Table 5 Controller Key Functions/Features

Number	Key	Function
2	back	Moves back one level in the menu structure.
3	menu	Moves to the main menu from other menus. This key is not active in menus where a selection or other input must be made.
4		Navigates through the menus, changes settings, and increments and decrements digits.
5	home	Moves to the Main Measurement screen from any other screen. This key is not active in menus where a selection or other input must be made.
6	enter	Accepts an input value, updates, or accepts displayed menu options.

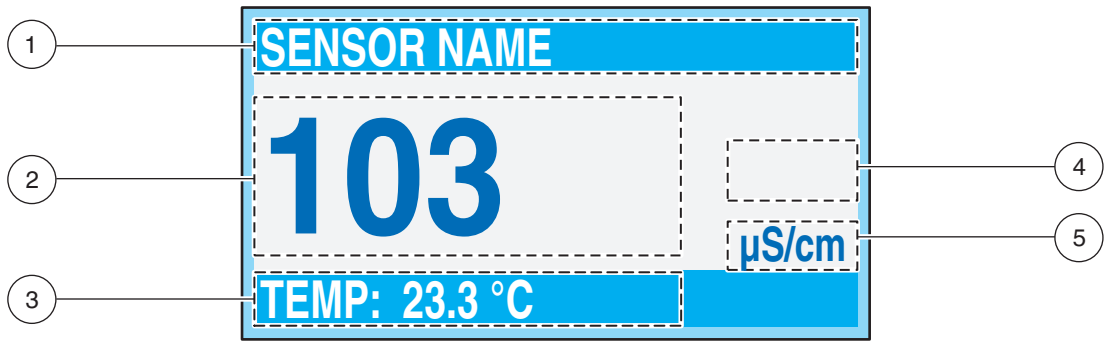
4.1.1 Controller Display Features

When a sensor is connected and the controller is in measurement mode, the controller display will show the current conductivity reading plus the sample temperature.

The display will flash on startup, when a sensor error has occurred, when the hold outputs function has been activated, and when a sensor is being calibrated.

An active system warning will cause the warning icon (a triangle with an exclamation point inside) to be displayed on the right side of the display.

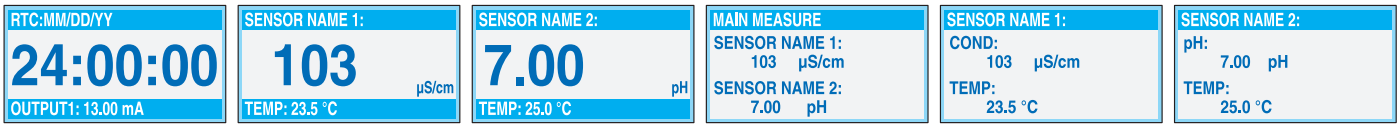
Figure 14 Display



1. Status bar. Indicates the sensor name and status of relays. The relay letter is displayed when the relay is energized.	**3.** Secondary measurement
	4. Warning icon area
2. Main measurement	**5.** Measurement units (µS, mS, S, mohm, TDS)

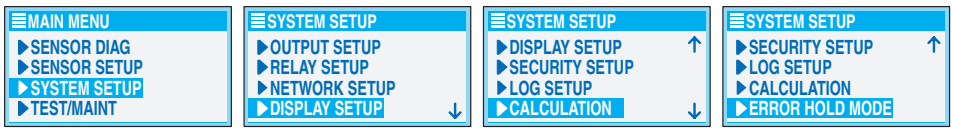
4.1.2 Important Key Presses

- Press the **HOME** key then the **RIGHT** or **LEFT** key to display two readings when two sensors are connected. Continue to press the **RIGHT** or **LEFT** key to toggle through the available display options as shown below.



- Press the **UP** and **DOWN** keys to toggle the status bar at the bottom of the measurement display to display the secondary measurement (temperature) and output information.

- When in Menu mode, an arrow may appear on the right side of the display to indicate that more menus are available. Press the **UP** or **DOWN** key (corresponding to the arrow direction) to display additional menus.



4.2 Using the sc1000 Controller

The sc1000 is a touch screen application. Use your finger to touch keys and menu commands. In normal operation the touch screen displays the measured values for the sensors selected.

4.2.1 Display Features

4.2.1.1 Using the Pop-up Toolbar

The pop-up toolbar provides access to the controller and sensor settings. The toolbar is normally hidden from view. To view the toolbar, touch the bottom-left of the screen.

Figure 15 Pop-up Toolbar Functions

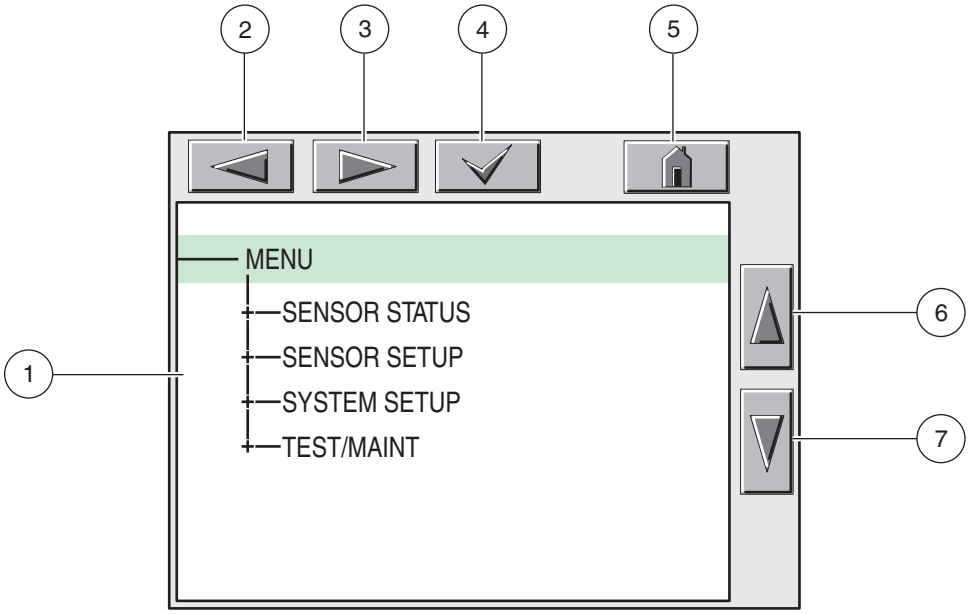
	MAIN MENU–displays the Main Menu Structure
	UP Arrow–scrolls up to the previous displayed value.
	Displays one value.
	Displays two values at the same time.
	Displays four values at the same time.
	LIST–displays the list of connected devices and sensors.
	DOWN Arrow–scrolls down to the next displayed value.

4.2.1.2 Using the Menu Windows

If the Menu button (from the pop-up toolbar) is selected, the Main Menu screen is opened. The Main Menu screen allows the user to view the sensor status, configure the sensor setup, system setup, and perform diagnostics.

The menu structure may vary depending on the configuration of the system.

Figure 16 Main Menu



1.	Display Area
2.	**BACK**
3.	**FORWARD**
4.	**ENTER**–confirms the entry or selection.
5.	**HOME**–changes to the display of measured values. The pop-up toolbar cannot open from the menu window. To view the Main Menu from this display, touch the Home button and then the bottom of the screen.
6.	**UP**–scrolls up
7.	**DOWN**–scrolls down

4.2.1.3 Navigating the Menu Windows

To view a menu item, touch the menu item or use the **UP** and **DOWN** keys to highlight the item. The menu item remains highlighted for approximately 4 seconds after it is selected. To view the highlighted command, select the area to the left of the menu item or select the **ENTER** button.

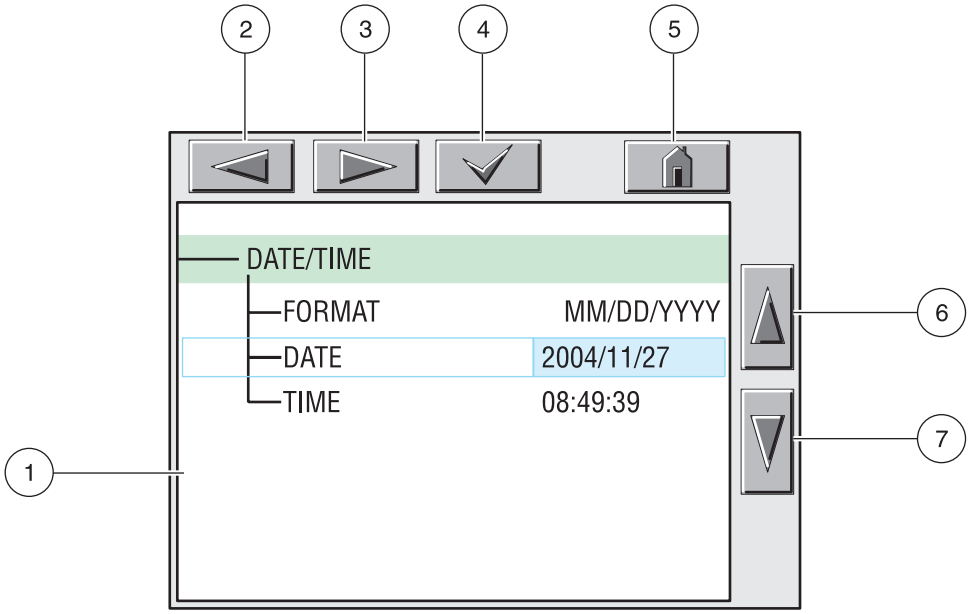
A "**+**" next to a menu command indicates there is a submenu. Touch the "+" to view the submenu. An "**i**" next to a menu command indicates it is information only.

If a menu item is editable, highlight the item and touch the far-left part of the menu item until it is highlighted and press **ENTER** or double-tap the highlighted item. A keypad will be displayed to change an entry (Figure 18 on page 23) or a list box will be displayed (Figure 19 on page 24).

Messages are displayed in the message window (Figure 20 on page 24).

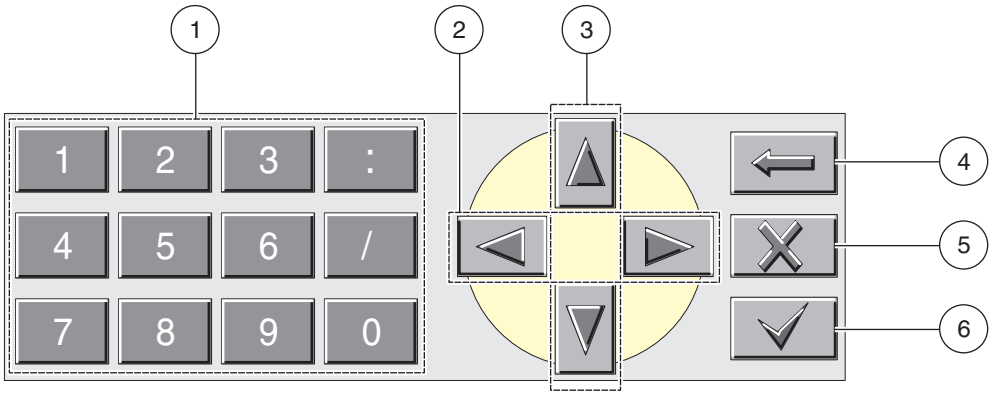
If an entry is incorrect, repeat the entry with the correct values. If the entry is outside the working range, a correction to the entry is made automatically.

Figure 17 Changing a Menu Item



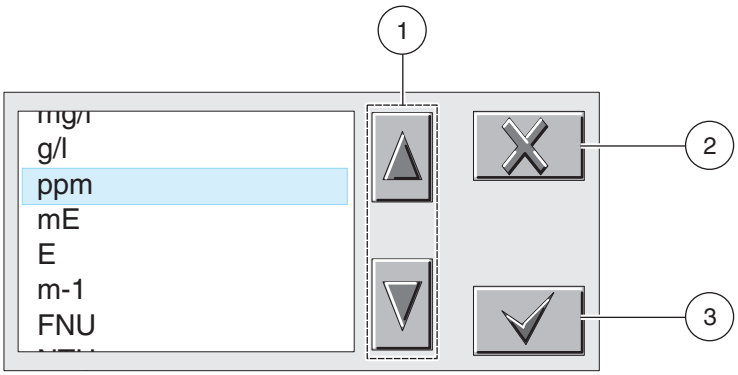
1.	Display Area	**5.**	**HOME**–changes to the display of measured values.
2.	**BACK**	**6.**	**UP**–scrolls up
3.	**FORWARD**	**7.**	**DOWN**–scrolls down
4.	**ENTER**–confirms the entry or selection.		

Figure 18 Keypad



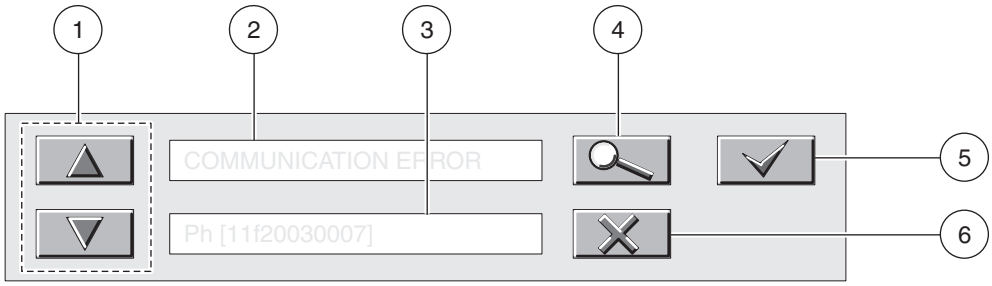
1.	Enters numbers or the character as shown on the button.
2.	Moves the cursor one position to the left or to the right.
3.	Increase/Decrease a number or letter at the cursor position. Keep the button pressed to change the numbers/characters continuously.
4.	Deletes the character to the left of the cursor.
5.	**CANCEL**–cancels the entry.
6.	**ENTER**–confirms the entry or selection.

Figure 19 List Box



1.	Scrolls up or down
2.	**CANCEL**–cancels and entry.
3.	**ENTER**–confirms a selection.

Figure 20 Message window



1.	Scrolls up or down.
2.	Displays the messages or warnings.
3.	Displays details on the selected entry.
4.	This button changes back to the previous display.
5.	**ENTER**–confirms an entry.
6.	**CANCEL**–cancels an entry.

Section 5 Operation

5.1 Sensor Setup

When a sensor is initially installed, the serial number of the sensor will be displayed as the sensor name. To change the sensor name refer to the following instructions:

1. Select Main Menu.
2. From the Main Menu, select SENSOR SETUP and confirm.
3. Highlight the appropriate sensor if more than one sensor is attached and confirm.
4. Select CONFIGURE and confirm.
5. Select EDIT NAME and edit the name. Confirm or cancel to return to the Sensor Setup menu.

5.2 Sensor Data Logging

The sc controller provides one data log and one event log for each sensor. The data log stores the measurement data at selected intervals. The event log stores a variety of events that occur on the devices such as configuration changes, alarms, warning conditions, etc. The data log and the event log can be read out in a CSV format. For downloading the logs please refer to the controller user manual.

5.3 Sensor Diagnostics Menu for pH and ORP Menu

SELECT SENSOR (if more than one sensor is attached)

STATUS	
ERROR LIST	See section 7.1 on page 35.
WARNING LIST	See section 7.2 on page 35.

5.4 pH Sensor Setup Menu

SELECT SENSOR (if more than one sensor is attached)

CALIBRATE	
1-POINT AUTO	Calibration with a single buffer — normally pH 7.
2-POINT AUTO	Calibration with two buffers — normally pH 7 and pH 4 or 10.
1-POINT MANUAL	Calibration against a single known sample.
2-POINT MANUAL	Calibration against two samples, both with a known pH.
TEMP ADJUST	Adjust the displayed temperature by up to ± 15 °C.
DEFAULT SETUP	Restores the system to the original factory calibration.

5.4 pH Sensor Setup Menu (continued)

CONFIGURE	
EDIT NAME	Enter a 10-digit name in any combination of symbols and alpha or numeric characters.
SELECT MEASURE	Select the appropriate measurement units to display.
DISPLAY FORMAT	Select the measurement resolution (xx.xx pH or xx.x pH).
TEMP UNITS	Choose from the displayed options (°C or °F).
LOG SETUP	Choose SENSOR INTERVAL to set the sensor log interval or select TEMP INTERVAL to set the temperature log interval.
REJECT FREQUENCY	Choose 50 or 60 Hz depending on the power line frequency for optimal noise rejection. Default is 60 Hz.
FILTER	Select 0–60 second signal averaging time.
TEMP ELEMENT	Select type of temperature element from the displayed choices.
SELECT BUFFER	Select the buffer type (standard 4, 7, 10 or DIN 19267) from the displayed choices.
PURE H20 COMP	Allows the user to specify that ammonia, morpholine, or other user-defined electrolyte is being used in the application, allowing a temperature-dependent linear slope factor to be applied to the measured pH.
CAL DAYS	Number of days since the last calibration. Default notification at 60 days.
SENSOR DAYS	Number of days the sensor has been in operation. Default notification at 365 days.
DEFAULT SETUP	Resets all user-editable options to their factory-defaults.
DIAG/TEST	
PROBE INFO	Display the sensor type, entered name of the sensor (Default: sensor serial number.), the sensor serial number, the software version number, and the sensor driver version number.
CAL DATA	Displays the pH slope and the date of the last calibration
SIGNAL	SENSOR SIGNAL: Displays the sensor output in mV SENSOR ADC COUNTS: Displays the sensor ADC counts TEMP ADC COUNTS: Displays raw data for temperature ADC counts. ADC counts are comparable to A/D counts and are for sensor electronic diagnostic purposes only. ELECTRODE STATE: Identifies the state of the electrode (good or bad) depending on whether the impedance is within preset limits. ACTIVE ELECT: Displays the impedance (Mohms) of the active electrode if Imped Status is set to Enabled. REF. ELECTRODE: Displays the impedance (Mohms) of the reference electrode if Imped Status is set to Enabled. IMPED STATUS: Sensor diagnostic. Choose Enabled or Disabled.
COUNTERS	SENSOR DAYS: displays the cumulative days the sensor has been in use. RESET SENSOR: Allows the sensor counter to be reset to zero. ELECTRODE DAYS: Cumulative days the electrode has been in use.

5.5 ORP Sensor Setup Menu

SELECT SENSOR (if more than one sensor is attached)

CALIBRATE	
1-POINT MANUAL	Calibration against a single known sample.
TEMP ADJUST	Adjust the displayed temperature by up to ± 15 °C.
DEFAULT SETUP	Restores the system to the original factory calibration.
CONFIGURE	
EDIT NAME	Enter up to a 10-digit name in any combination of symbols and alpha or numeric characters. Press **ENTER** when the entry is complete. The name will be displayed on the status line with the measurement value.
SELECT SENSOR	Choose from the displayed sensor type (pH or ORP).
TEMP UNITS	Choose from the displayed options (°C or °F).
LOG SETUP	Choose SENSOR INTERVAL to set the sensor log interval or select TEMP INTERVAL to set the temperature log interval.
AC FREQUENCY	Choose 50 or 60 Hz depending on the power line frequency for optimal noise rejection. Default is 60 Hz.
FILTER	Select 0–60 second signal averaging time.
TEMP ELEMENT	Select type of temperature element from the displayed choices.
SELECT BUFFER	Select the buffer type (standard 4, 7, 10 or DIN 19267) from the displayed choices.
PURE H20 COMP	Allows the user to specify that ammonia, morpholine, or other user-defined electrolyte is being used in the application, allowing a temperature-dependent linear slope factor to be applied to the measured pH.
CAL DAYS	Number of days since the last calibration. Default notification at 60 days.
SENSOR DAYS	Number of days the sensor has been in operation. Default notification at 365 days.
IMPED LIMITS	Set min/max electrode sensor impedance limits.
DEFAULT SETUP	Resets all user-editable options to their factory-defaults.
DIAG/TEST	
PROBE INFO	Display the sensor type, entered name of the sensor (Default: sensor serial number.), the sensor serial number, the software version number, and the sensor driver version number.
CAL DATA	Displays the pH slope and the date of the last calibration
SIGNAL	SENSOR SIGNAL: displays the sensor output in mV SENSOR ADC COUNTS: displays the sensor ADC counts TEMP ADC COUNTS: shows raw data for temperature ADC counts. ADC counts are comparable to A/D counts and are for sensor electronic diagnostic purposes only. ELECTRODE STATE: Identifies the state of the electrode (good or bad) depending on whether the impedance is within preset limits. ACTIVE ELECT: Shows the impedance (Mohms) of the active electrode if Imped Status is set to Enabled. REF. ELECTRODE: Shows the impedance (Mohms) of the reference electrode if Imped Status is set to Enabled. IMPED STATUS: Sensor diagnostic. Choose Enabled or Disabled.
COUNTERS	SENSOR DAYS: displays the cumulative days the sensor has been in use. RESET SENSOR: allows the sensor counter to be reset to zero. ELECTRODE DAYS: Cumulative days the electrode has been in use.

5.6 pH Calibration

The manufacturer offers one and two point automatic and manual calibrations for pH. An automatic calibration identifies the buffer table corresponding to the chosen buffer and automatically calibrates the probe after it stabilizes. A manual calibration is performed by placing the pH sensor in any buffer or sample with a known value and then entering that known value into the controller.

The value of the sample used in the manual calibration may be determined by laboratory analysis or comparison reading.

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Select the appropriate sensor if more than one is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select 1 POINT AUTO. Select the available Output Mode (Active, Hold, or Transfer) and confirm.
5. Move the clean probe to buffer and confirm to continue.
6. Confirm when stable. A screen will display 1 Point Auto Complete and the slope (XX.X mV/pH).
7. Return the probe to process.

5.6.1 Two Point Automatic Calibration

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Select the appropriate sensor if more than one is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select 2 POINT AUTO. Select the available Output Mode (Active, Hold, or Transfer) and confirm.
5. Move the clean probe to Buffer 1 and confirm.
6. Confirm when stable.
7. Move the clean probe to Buffer 2 and confirm.
8. Confirm when stable. A screen will display 2 Point Calibration Complete and the slope (XX.X mV/pH).
9. Return the probe to process.

5.6.2 One Point Manual Calibration

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Select the appropriate sensor if more than one is attached and confirm.
3. Select CALIBRATE and confirm.

4. Select 1 POINT MANUAL. Select the available Output Mode (Active, Hold, or Transfer) and confirm.

5. Move the clean probe to solution and confirm to continue.

6. Confirm when stable. Edit the solution value and confirm.

7. Confirm when stable. A screen will display 1 Point Manual Complete and the slope (XX.X mV/pH).

8. Return the probe to process.

5.6.3 Two Point Manual Calibration

1. From the Main Menu, select SENSOR SETUP and confirm.

2. Select the appropriate sensor if more than one is attached and confirm.

3. Select CALIBRATE and confirm.

4. Select 2 POINT MANUAL CAL. Select the available Output Mode (Active, Hold, or Transfer) and confirm.

5. Move the clean probe to Solution 1 and confirm.

6. Confirm when stable. Edit the solution value and confirm.

7. Move probe to solution 1 and confirm.

8. Confirm when stable. Edit the solution value and confirm.

9. A screen will display 2 Point Manual Cal Complete and the slope (XX.X mV/pH).

10. Return the probe to process.

5.7 ORP Calibration

The manufacturer offers a one point manual calibration for ORP. The value of the sample used in the manual calibration may be determined by laboratory analysis or comparison reading.

1. From the Main Menu, select SENSOR SETUP and confirm.

2. Select the appropriate sensor if more than one is attached and confirm.

3. Select CALIBRATE and confirm.

4. Select 1 POINT MANUAL CAL. Select the available Output Mode (Active, Hold, or Transfer) and confirm.

5. Move the clean probe to Solution and confirm.

6. Confirm when stable. Edit the solution value and confirm.

7. A screen will display 1 Point Manual Complete and the slope (XX.X mV).

8. Return the probe to process.

5.8 Concurrent Calibration of Two Sensors for pH and ORP

1. Begin a calibration on the first sensor and continue until “Wait to Stabilize” is displayed.
2. Select LEAVE and confirm. The display will return to the main measurement screen. The reading for the sensor currently being calibrated will flash.
3. Begin the calibration for the second sensor and continue until “Wait to Stabilize” is displayed.
4. Select LEAVE and confirm. The display will return to the main measurement screen and the reading for both sensors will flash. The calibration for both sensors are now running in the background.
5. To return to the calibration of either sensor select SENSOR SETUP from the Main Menu and confirm. Select the appropriate sensor and confirm.
6. The calibration in progress will be displayed. Continue with the calibration.

5.9 Adjusting the Temperature

View or change the temperature using the steps below.

1. From the Main Menu, select SENSOR SETUP and confirm.
2. Select the appropriate sensor if more than one is attached and confirm.
3. Select CALIBRATE and confirm.
4. Select TEMP ADJUST and confirm.
5. Select MEASURED TEMP and confirm.
6. The temperature will be displayed. Edit the temperature and confirm.

DANGER
Only qualified personnel should conduct the tasks described in this section of the manual.

DANGER
Seul un technicien qualifié peut effectuer les tâches d'installation décrites dans cette section du manuel.

DANGER
Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

DANGER
Risque d'explosion. Couper le courant ou s'assurer que l'emplacement est designe non dangereux avant de replacer le aucon composant.

DANGER
Explosion hazard. Substitution of components may impair suitability for Class 1, Division 2.

DANGER
Risque d'explosion. La substitution de composants peut rendre ce materiel inacceptable pour les emplacements de Classe 1, Division 2..

6.1 Maintenance Schedule

Maintenance Task	90 days	Annually
Clean the sensor[1]	x	
Inspect sensor for damage	x	
Replace Salt Bridge and fill solution[2]		x
Calibrate Sensor (as required by regulatory agency)	**Per the schedule mandated by your regulatory agency.**	

[1] Cleaning frequency is application dependent. More or less frequent cleaning will be appropriate in some applications.
[2] Salt bridge replacement frequency is application dependent. More or less frequent replacement will be appropriate in some applications

6.2 Cleaning the Sensor

CAUTION
Before cleaning with acid, determine if the chemical reaction between the acid and the sample will create a hazardous chemical reaction. (For example, do not put a sensor that is used in a cyanide bath directly into a strong acid for cleaning because this chemical combination may produce poisonous cyanide gas.)

1. Clean the exterior of the sensor with a stream of water. If debris remains remove loose contaminate buildup by carefully wiping the entire measuring end of the sensor (process electrode, concentric metal ground electrode, and salt bridge) with a soft clean cloth. Rinse the sensor with clean, warm water.

2. Prepare a mild soap solution of warm water and dish detergent or other non-abrasive soap that does not contain lanolin such as laboratory glass cleaner.

Note: *Lanolin will coat the glass process electrode and can adversely affect sensor performance.*

3. Soak the sensor for 2 to 3 minutes in the soap solution.

4. Use a small soft bristle brush (such as a toothbrush) and scrub the entire measuring end of the sensor, thoroughly cleaning the electrode and salt bridge surfaces. If surface deposits cannot be removed by detergent solution cleaning, use muriatic acid (or other dilute acid) to dissolve them. The acid should be as dilute as possible. Experience will determine which acid to use and the appropriate dilution ratio. Some stubborn coatings may require a different cleaning agent. For assistance, contact Technical and Customer Service (U.S.A. only) on page 41.

DANGER
Acids are hazardous. Always wear appropriate eye protection and clothing in accordance with material safety data sheet recommendations.

5. Soak the entire measuring end of the sensor in dilute acid for no more than 5 minutes. Rinse the sensor with clean, warm water then place the sensor back into the mild soap solution for 2 to 3 minutes to neutralize any remaining acid.

6. Remove the sensor from the soap solution, and rinse the sensor again in clean, warm water.

7. After cleaning, always calibrate the measurement system.

6.2.1 Replacing the Standard Cell Solution and Salt Bridge

If calibration cannot be attained, rejuvenate the sensor by replacing its standard cell solution and salt bridge as shown in Figure 21. If calibration is still not possible, refer to Section 7 on page 35.

1. To remove the salt bridge, hold the sensor upright (electrode at top), and use pliers or a similar tool to turn it counterclockwise. Take care not to damage the protruding process electrode. Properly discard the old salt bridge.

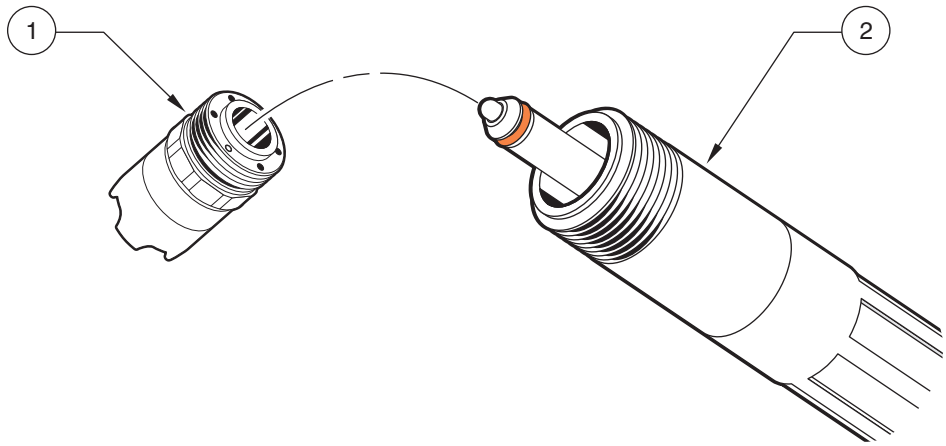
2. Replace the standard cell solution in the sensor reservoir.

   a. Pour out the aged solution, and thoroughly flush the reservoir with distilled water.

   b. Fill the reservoir to the bottom of the salt bridge threads with fresh standard cell solution (Cat. No. 25M1A1025-115).

3. Install a new o-ring then carefully thread the new salt bridge clockwise until it is finger-tight and the bottom surface of the salt bridge is in full contact with the top surface of the sensor body. Do not over tighten.

Figure 21 Replacing Standard Cell Solution and Salt Bridge



1. Salt Bridge	**2.** Sensor

Section 7 Troubleshooting

7.1 Error Codes

When a sensor is experiencing an error condition, the sensor reading on the measurement screen will flash and all relays and analog outputs associated with the sensor will be held. The following conditions will cause the sensor reading to flash:

- Sensor calibration
- Relay timer washing cycle
- Loss of communication

Highlight the Sensor Diag menu and press **ENTER**. Highlight Errors and press **ENTER** to determine the cause of the error.

Errors are defined in Table 6.

Table 6 Error Codes

Displayed Error	Definition	Resolution
ADC FAILURE	System measurement fails	Contact Technical Consulting Services.

7.2 Warnings

A sensor warning will leave all menus, relays, and outputs functioning normally, but will cause a warning icon to flash on the right side of the display. Highlight the Sensor Diag menu and press **ENTER** to determine the cause of the warning.

A warning may be used to trigger a relay and users can set warning levels to define the severity of the warning. Errors are defined in Table 7.

Table 7 Warning Codes

Displayed Warning	Definition	Resolution
PROBE OUT RANGE	Measured pH/ORP exceeds the expected value range.	Contact Technical Consulting Services.
TEMP OUT RANGE	Measured temperature exceeds the expected value range.	Contact Technical Consulting Services.
FLASH FAILURE	System flash memory write has failed.	Contact Technical Consulting Services.
ACTIVE. ELEC	Standard electrode is not performing within the required specifications.	Contact Technical Consulting Services.
REF. ELECTRODE	Reference electrode is not performing within the required specifications.	Contact Technical Consulting Services.
CAL REQUIRED	60 days has elapsed since the last calibration	Perform a calibration.
REPLACE SENSOR	One year has elapsed since the sensor has been installed.	Clean the sensor and replace the salt bridge and standard cell solution (see section 6.2 on page 32 and section 6.2.1 on page 33). Reset the counter in the SENSOR SETUP>CONFIGURE> SENSOR DAYS menu. If necessary, replace the sensor.

7.3 Troubleshooting the pH Sensor

Clean the sensor using the procedure described in section 6.2 on page 32. If the measuring system cannot be calibrated after cleaning, replace the standard cell solution and salt bridge (see section 6.2.1 on page 33) and try calibrating again. If the measuring system still cannot be calibrated, check the sensor operation.

Some simple tests using the sc100 or a multimeter and two pH buffers will determine if the pH sensor is operating properly. The use of pH 7 and pH 4 buffers is preferred but pH 10 can be used in place of pH 4 if it more closely covers the measurement range of interest.

Determine if the sensor has integral digital electronics or uses an external digital gateway. If the sensor uses a digital gateway, it will be hard-wired to the gateway through terminal connections inside the digital gateway enclosure. If the sensor uses the digital gateway and therefore does not have integral digital electronics, proceed with section 7.3.1. If the sensor has integral digital electronics, move to section 7.3.2 on page 37.

7.3.1 Troubleshooting a pH Sensor without Integral Digital Electronics

1. Disconnect the red, green, yellow, and black sensor wires from the digital gateway.

2. Place the sensor in a pH 7 buffer. Before continuing, allow the temperatures of the sensor and buffer to equalize to approximately 25 °C (70 °F).

3. Verify that the sensor temperature element (300 ohm thermistor) is operating properly by measuring the resistance between the yellow and black wires. The reading should be between 250 and 350 ohms at approximately 25 °C (70 °F).

4. Reconnect the yellow and black wires.

5. Connect the multimeter (+) lead to the red wire and (–) lead to the green wire. With the sensor in the pH 7 buffer, measure the dc millivolts. The sensor offset reading should be within the factory-specified limits of –50 and +50 mV. If it is, record the millivolt value reading and continue with step 6. If the reading is outside these limits, discontinue this test and contact Technical Support.

6. With the multimeter still connected, rinse the sensor with water and place it in either pH 4 or pH 10 buffer. Allow the temperatures of the sensor and buffer to equalize to approximately 25 °C (70 °F) then measure the sensor span reading as shown in Table 8 and Table 9 on page 37.

Span Reading in pH 4 Buffer
With the sensor in pH 4 buffer, the sensor span reading should be at least +160 mV more than the offset reading taken in step 5.

Table 8 Typical Span Reading Examples (pH 4 buffer)

Offset Reading (in pH 7 buffer)	Span Reading (in pH 4 buffer)
–50 mV	+110 mV
–25 mV	+135 mV
0 mV	+160 mV
+25 mV	+185 mV
+50 mV	+210 mV

Span Reading in pH 10 Buffer
With the sensor in pH 10 buffer, the sensor span reading should be at least –160 mV less than the noted offset reading taken in step 5.

Table 9 Typical Span Reading Examples (pH 10 buffer)

Offset Reading (in pH 7 buffer)	Span Reading (in pH 10 buffer)
–50 mV	–210 mV
–25 mV	–185 mV
0 mV	–160 mV
+25 mV	–135 mV
+50 mV	–110 mV

If the span reading is at least +160 mV more than or –160 mV less than the offset reading in pH 4 or pH 10, respectively, the sensor is within factory-specified limits. If not, contact Technical Support.

7.3.2 Troubleshooting the pH Sensor with Integral Digital Electronics

1. Place the sensor in pH 7 buffer and allow the buffer and sensor to reach temperature equilibrium. This can be verified by monitoring the sensor temperature value for a stable temperature measurement. This value is shown on the sc100 display when it is in measurement mode.

2. From the Sensor Setup Menu on the sc100, highlight “Diag/Test” and press **ENTER**.

3. Highlight “Sensor Signal” and press **ENTER**. This sensor offset reading should be within factory-specified limits of –50 and +50 mV. If it is, write down this millivolt value reading and perform step 4. If the reading is outside these limits, discontinue this test and contact Technical Support.

4. Rinse the sensor and place it in pH 4 or 10 buffer and allow the buffer and sensor to reach temperature equilibrium. This can be verified by monitoring the sensor temperature value for a stable temperature measurement. This value is located on the sc100 display when it is in measurement mode.

5. From the Sensor Setup Menu on the sc100, highlight “Diag/Test” and press **ENTER**.

6. Highlight “Sensor Signal” and press **ENTER**. Then measure the sensor span value.

Span Reading in pH 4 Buffer
With the sensor in pH 4 buffer, the sensor span reading should be at least +160 mV more than the offset reading as shown in Table 10 and Table 11.

Table 10 Typical Span Reading Examples (pH 4 buffer)

Offset Reading (in pH 7 buffer)	Span Reading (in pH 4 buffer)
–50 mV	+110 mV
–25 mV	+135 mV
0 mV	+160 mV
+25 mV	+185 mV
+50 mV	+210 mV

Span Reading in pH 10 Buffer
With the sensor in pH 10 buffer, the sensor span reading should be at least –160 mV less than the noted offset reading taken in step 6. Examples of typical readings:

Table 11 Typical Span Reading Examples (pH 10 buffer)

Offset Reading (in pH 7 buffer)	Span Reading (in pH 10 buffer)
–50 mV	–210 mV
–25 mV	–185 mV
0 mV	–160 mV
+25 mV	–135 mV
+50 mV	–110 mV

7. If the span reading is at least +160 mV more than or –160 mV less than the offset reading in pH 4 or pH 10, respectively, the sensor is within factory-specified limits. If not, contact Technical Support.

7.4 Checking ORP Sensor Operation

Simple tests using the sc100 or a multimeter and a 200 mV reference solution can determine if the ORP sensor is operating properly. Determine if the sensor has integral digital electronics or uses an external digital gateway. If the sensor uses a digital gateway, it will be hard-wired to the digital gateway through terminal connections within the digital gateway enclosure. If the sensor uses a digital gateway proceed with section 7.4.1. If the sensor has integral digital electronics, move to section 7.4.2 on page 38.

7.4.1 Troubleshooting the ORP Sensor without Integral Digital Electronics

1. Disconnect the red, green, yellow, and black sensor wires from the digital gateway.

2. Place the sensor in a 200 mV reference solution and allow the temperature of the sensor and reference solution to equalize to approximately 25 °C (70 °F).

3. Verify that the sensor temperature element (300 ohm thermistor) is operating by measuring the resistance between the yellow and black wires. The reading should be between 250 and 350 ohms at approximately 25 °C (70 °F).

4. Reconnect the yellow and black wires.

5. Connect the multimeter (+) lead to the red wire and (–) lead to the green wire. With the sensor in the 200 mV reference solution, measure the dc millivolts. The reading should be between 160 and 240 mV. If the reading is outside these limits, contact Technical Support.

7.4.2 Troubleshooting the ORP Sensor with Integral Digital Electronics

1. Place the sensor in 200 mV reference solution and allow the buffer and sensor to reach temperature equilibrium. This can be verified by monitoring the sensor temperature value for a stable temperature measurement. This value is located on the sc100 display when it is in measurement mode.

2. From the Sensor Setup Menu on the sc100, highlight “Diag/Test” and press **ENTER**. Highlight “Sensor Signal” and press **ENTER**. The reading should be between 160 and 240 mV. If the reading is outside these limits, contact Customer Service.

Section 8 Replacement Parts and Accessories

8.1 Replacement Items, Accessories, and Reagent and Standards

Item Description	QTY	Catalog Number
Air blast cleaning system, 115 V, includes Kynar® (PVDF) washer head with 7.6 m (25 ft) tubing and quick connect fitting, and a compressor in a NEMA 4X enclosure	each	1000A3335-005
Air blast cleaning system, 230 V, includes Kynar® (PVDF) washer head with 7.6 m (25 ft) tubing and quick connect fitting, and a compressor in a NEMA 4X enclosure	each	1000A3335-006
Air/Water blast cleaning head	each	1000A3335-004
Buffer, pH 7	500 mL (1 pint)	2283549
Buffer, pH 4	500 mL (1 pint)	2283449
Buffer, pH 10	500 mL (1 pint)	2283649
Buffer, pH 7	1 gallon	2283556
Buffer, pH 4	1 gallon	2283456
Buffer, pH 10	1 gallon	2283656
Buffer, pH 7	500 mL (1 pint)	2283549
Cable, interconnect, unterminated ends, specify length in whole feet	each	1W1100
Cable, sensor extension, 1 m (3 ft)	each	6122400
Cable, sensor extension, 7.7 m (25 ft)	each	5796000
Cable, sensor extension, 15 m (50 ft)	each	5796100
Cable, sensor extension, 31 m (100 ft)	each	5796200
Connector Cable	each	6139900
Instruction manual, Differential pH System, English	each	6120218
Plug, sealing, conduit opening	each	5868700
O-ring, Viton	each	5H1304
O-ring, EPDM	each	5H1306
O-ring, Perflouro	each	5H1096-019
ORP Standard Solution, 200 mV	500 mL (1 pint)	25M2A1001-115
ORP Standard Solution, 600 mV	500 mL (1 pint)	25M2A1002-115
ORP Standard Solution, 200 mV	1 gallon	25M2A1001-123
ORP Standard Solution, 600 mV	1 gallon	25M2A1002-123
Salt Bridge, PEEK® Body, PVDF outer junction	each	SB-P1SV
Salt Bridge Ryton® Body, PVDF outer junction	each	SB-R1SV
Standard Cell Solution	each	25M1A1025-115
Strain relief, Heyco	each	16664

Section 9 How to Order

U.S.A. Customers

By Telephone:
6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH (800-227-4224)

By Fax:
(970) 669-2932

By Mail:
Hach Company
P.O. Box 389
Loveland, Colorado 80539-0389 U.S.A.
Ordering information by e-mail: orders@hach.com

Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

International Customers

Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send an e-mail to: intl@hach.com or contact:

Hach Company World Headquarters; Loveland, Colorado, U.S.A.
Telephone: (970) 669-3050; Fax: (970) 669-2932

Technical and Customer Service (U.S.A. only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use. Specialists in analytical methods, they are happy to put their talents to work for you.

Call 1-800-227-4224 or e-mail techhelp@hach.com

Section 10 Repair Service

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the Hach Service Center serving your location.

In the United States:
Hach Company
Ames Service
100 Dayton Avenue
Ames, Iowa 50010
(800) 227-4224 (U.S.A. only)
FAX: (515) 232-3835

In Canada:
Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
(800) 665-7635 (Canada only)
Telephone: (204) 632-5598
FAX: (204) 694-5134
E-mail: canada@hach.com

**In Latin America, the Caribbean, the Far East,
Indian Subcontinent, Africa, Europe, or the Middle East:**
Hach Company World Headquarters,
P.O. Box 389
Loveland, Colorado, 80539-0389 U.S.A.
Telephone: (970) 669-3050
FAX: (970) 669-2932
E-mail: intl@hach.com

Section 11 Limited Warranty

Hach Company warrants its products to the original purchaser against any defects that are due to faulty material or workmanship for a period of one year from date of shipment unless otherwise noted in the product manual.

In the event that a defect is discovered during the warranty period, Hach Company agrees that, at its option, it will repair or replace the defective product or refund the purchase price excluding original shipping and handling charges. Any product repaired or replaced under this warranty will be warranted only for the remainder of the original product warranty period.

This warranty does not apply to consumable products such as chemical reagents; or consumable components of a product, such as, but not limited to, lamps and tubing.

Contact Hach Company or your distributor to initiate warranty support. Products may not be returned without authorization from Hach Company.

Limitations

This warranty does not cover:

- Damage caused by acts of God, natural disaster, labor unrest, acts of war (declared or undeclared), terrorism, civil strife or acts of any governmental jurisdiction
- Damage caused by misuse, neglect, accident or improper application or installation
- Damage caused by any repair or attempted repair not authorized by Hach Company
- Any product not used in accordance with the instructions furnished by Hach Company
- Freight charges to return merchandise to Hach Company
- Freight charges on expedited or express shipment of warranted parts or product
- Travel fees associated with on-site warranty repair

This warranty contains the sole express warranty made by Hach Company in connection with its products. All implied warranties, including without limitation, the warranties of merchantability and fitness for a particular purpose, are expressly disclaimed.

Some states within the United States do not allow the disclaimer of implied warranties and if this is true in your state the above limitation may not apply to you. This warranty gives you specific rights, and you may also have other rights that vary from state to state.

This warranty constitutes the final, complete, and exclusive statement of warranty terms and no person is authorized to make any other warranties or representations on behalf of Hach Company.

Limitation of Remedies

The remedies of repair, replacement or refund of purchase price as stated above are the exclusive remedies for the breach of this warranty. On the basis of strict liability or under any other legal theory, in no event shall Hach Company be liable for any incidental or consequential damages of any kind for breach of warranty or negligence.

Section 12 Compliance Information

Hach Co. certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.

The **Model sc100/sc1000 Controller with Differential pH/ORP sensor** has been tested and is certified as indicated to the following instrumentation standards:

Product Safety

UL 61010A-1 (ETL Listing # 65454)
CSA C22.2 No. 1010.1 (ETLc Certification # 65454)
Certified by Hach Co. to EN 61010-1 Amds. 1 & 2 (IEC1010-1) per 73/23/EEC, supporting test records by Intertek Testing Services.

Immunity

This equipment was tested for industrial level EMC per:

EN 61326 (EMC Requirements for Electrical Equipment for Measurement, Control and Laboratory Use) **per 89/336/EEC EMC:** Supporting test records by Hach Company, certified compliance by Hach Company.

Standards include:

IEC 1000-4-2:1995 (EN 61000-4-2:1995) Electrostatic Discharge Immunity (Criteria B)
IEC 1000-4-3:1995 (EN 61000-4-3:1996) Radiated RF Electromagnetic Field Immunity (Criteria A)
IEC 1000-4-4:1995 (EN 61000-4-4:1995) Electrical Fast Transients/Burst (Criteria B)
IEC 1000-4-5:1995 (EN 61000-4-5:1995) Surge (Criteria B)
IEC 1000-4-6:1996 (EN 61000-4-6:1996) Conducted Disturbances Induced by RF Fields (Criteria A)
IEC 1000-4-11:1994 (EN 61000-4-11:1994) Voltage Dip/Short Interruptions (Criteria B)

Additional Immunity Standard/s include:

ENV 50204:1996 Radiated Electromagnetic Field from Digital Telephones (Criteria A)

Emissions

This equipment was tested for Radio Frequency Emissions as follows:

Per **89/336/EEC** EMC: **EN 61326:1998** (Electrical Equipment for measurement, control and laboratory use—EMC requirements) Class “A” emission limits. Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company.

Standards include:

EN 61000-3-2 Harmonic Disturbances Caused by Electrical Equipment
EN 61000-3-3 Voltage Fluctuation (Flicker) Disturbances Caused by Electrical Equipment

Additional Emissions Standard/s include:

EN 55011 (CISPR 11), Class “A” emission limits

Canadian Interference-causing Equipment Regulation, IECS-003, Class A

Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company.

This Class A digital apparatus meets all requirements of the Canadian Interference-causing Equipment Regulations.
Cet appareil numèrique de la classe A respecte toutes les exigences du Rëglement sur le matÈriel brouilleur du Canada.

FCC PART 15, Class “A” Limits

Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense. The following techniques of reducing the interference problems are applied easily.

1. Disconnect the Controller from its power source to verify that it is or is not the source of the interference.

2. If the Controller is connected into the same outlet as the device with which it is interfering, try another outlet.

3. Move the Controller away from the device receiving the interference.

4. Reposition the receiving antenna for the device receiving the interference.

5. Try combinations of the above.

Appendix A General pH Information

A.1 pH Measurement Theory

pH is the negative logarithm of the hydrogen ion activity and a measure of the acidity or alkalinity of a solution.

$$pH = -\log A[H+]$$

pH is normally measured using a glass electrode and a reference electrode.

The glass electrode acts as a transducer, converting chemical energy (the hydrogen ion activity) into an electrical energy (measured in millivolts). The reaction is balanced and the electrical circuit is completed by the flow of ions from the reference solution to the solution under test.

The electrode and reference solution together develop a voltage (emf) whose magnitude depends on the type of reference electrode, the internal construction of the glass electrode, the pH of the solution and the temperature of the solution. This voltage is expressed by the Nernst Equation:

$$E = E_o - (2.3\ RT/F) \times \log A[H+]$$
$$E = E_o - (\text{slope}) \times \log A[H+]$$

where:

E = the emf of the cell

E_o = the zero potential (isopotential) of the system. It depends on the internal construction of the glass and reference electrodes.

R = gas constant

T = temperature in Kelvin

A[H+] = activity of the hydrogen ion (assumed to be equivalent to the concentration of hydrogen ions)

F = Faraday constant

For every unit change in pH (or decade change in ion concentration) the emf of the electrode pair changes by 59.16 mV at 25 °C. This value is known as the Nernstian Slope of the electrode.

The pH electrode pair is calibrated using solutions of known and constant hydrogen ion concentration, called buffer solutions. The buffer solutions are used to calibrate both the electrode isopotential and slope.

A.2 PID Controller Basics

A pH control loop operates as follows: The pH meter measures the value of the pH in the effluent, and, if the pH is different from the setpoint, the controller actuates the reagent pump (or valve) that adds reagent to a mixing tank. The added reagent adjusts the pH value of the process.

The physical layout of the loop, the sizing of the pump (valve), type of mixing tank, and location of the pH electrodes all have a major impact on the ultimate performance of the loop, after the controller is tuned for optimal performance. The largest single performance factor is the delay time around the loop. This includes the response time of the electrode/meter, time required to deliver the reagent to the process water, time required for the reagent to mix with and react with the process water, and the time required to deliver the completely mixed water to the electrode. If the delay times are too long or the mixing is not complete, the control will be poor regardless of how well the controller is tuned.

The Process pH Meter uses a PID (proportional, integral (reset), derivative (rate) control) control algorithm. Each of the instrument settings along with their effects on the control loop, are described below.

Mode
Manual: The manual output is specified in percent of full-scale PID output (4–20 mA) and is commonly used for testing the output device.

Auto: Allows the process to be controlled automatically using information specified in the Phase, Setpoint, Proportional Band, Integral, and Derivative menus as follows:

Phase
Direct: The control output action will cause the process value to increase.

Reverse: The control output action will cause the process value to decrease.

Setpoint
The setpoint is defined as the desired process value in pH

Proportional Band
The proportional band is the range in pH from the setpoint value where the controller provides proportional control. For example, the desired setpoint for the process is pH 7.0 and the process requires that a reagent must be added to the process water to bring it up to pH 7.0. If the proportional band is set to pH 1.0, the controller will provide proportional output control over the range of pH 6.0 to 8.0. When the process is at pH 6.0, the controller will provide a 100% control output level (assuming that Phase is set to Direct). When the process is at pH 7.0, the proportional control will provide a 0% control output level. When the process is at pH 6.5 the proportional control will provide a 50% output. The output action is equal to the difference between the setpoint and the process value, divided by the proportional band value.

Integral
The integral value is used to reduce the steady state error, between the process value and the setpoint, to zero. For example, assume a process can be manually controlled at a level of pH 8.0 by sending a 35% control output level to a reagent pump. Now, say that the system is set up for the controller to provide proportional only control, with the controller setpoint set to pH 8.0 and the proportional band set to pH 1.0. Note that the nearer the process gets to the pH 8.0 setpoint, the lower the control output level is. In fact, when the process is at pH 8.0, the output level will be 0%. Since the process requires that the pump be operated at 35% for the process to reach pH 8.0, its apparent that proportional-only

control will never quite reach the desired setpoint of pH 8.0. This is where the integral control comes in.

Integral control can be thought of as adding up the output action from the proportional control over time. For example, the proportional control output reaches a steady state level of 5%. If the integral time is set to five minutes, the integral action of the controller will add an additional 5% to the controller output level over a 5-minute interval. The integral action is additive, so for every 5-minute interval an additional 5% is added to the controller's output level. This will allow the controller to bring the process to the desired setpoint level. Note that the longer the integral time setting, the longer it takes for the integral action to affect the process. The integral control action is disabled by setting it to zero. Note that the integral time is in minutes.

Derivative

Derivative control is used to adjust the control output level based upon the rate at which the process value is approaching or passing the setpoint. Derivative control action would be used in cases where the process value can rapidly ramp up and overshoot the setpoint. The derivative setting is in minutes. The output action of the derivative control is equal to the rate of change of the process (in pH units per minute) times the derivative time, divided by the proportional band, times negative one. For example, if the process pH is changing at a rate of pH 0.20 per minute, the derivative time is set to 3.0 minutes, the proportional band is set to pH 0.80, and the action is “direct” the derivative control output action will be approximately equal to: (–0.20 pH/minute X 3.0 minute) /0.80 pH = –75%.

During calibration, the analog outputs can remain active, be held, or be transferred to a preset mA value.

Appendix B Modbus Register Information

Table 12 Sensor Modbus Registers

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Tags	SensorMeasTag	40001	Integer	1	R	Sensor measurement tag
Measurements	pHMeas	40002	Float	2	R	pH /ORP measurement
Tags	TempMeasTag	40004	Integer	1	R	Temperature measurement tag
Measurements	TempDegCMeas	40005	Float	2	R	Temperature measurement
Configuration	SensorName	40007	String	6	R/W	Sensor name
Tags	FuncCode	40013	Integer	1	R/W	Function code tag
Tags	NextState	40014	Integer	1	R/W	Next state tag
Configuration	MeasType	40015	Integer	1	R/W	Measurement type-pH or ORP
Configuration	TempUnits	40016	Integer	1	R/W	Temperature units-C or F
Configuration	pHFormat	40017	Integer	1	R/W	pH display format
Configuration	TaggedPhFormat	40018	Long	2	R	pH display tagged format
Configuration	Filter	40020	Integer	1	R/W	Sensor filter
Configuration	TempElementType	40021	Integer	1	R/W	Temperature element type
Tags	TempUserValueTag	40022	Integer	1	R	Temperature user value tag
Configuration	TempUserDegCValue	40023	Float	2	R/W	Temperature user value
Configuration	pHBuffer	40025	Integer	1	R/W	pH buffer type
Configuration	PureWaterCompType	40026	Integer	1	R/W	Pure H_2O compensation type
Configuration	PureWaterCompUser	40027	Float	2	R/W	Pure H_2O compensation user val
Calibration	OutputMode	40029	Integer	1	R/W	Output mode
Calibration	CalLeave	40030	Integer	1	R/W	Cal leave mode
Calibration	CalAbort	40031	Integer	1	R/W	Cal abort mode
Tags	CalEditValueTag	40032	Integer	1	R	Cal edit value tag
Calibration	CalEditPhValue	40033	Float	2	R/W	Cal edit value
Diagnostics	pHSlope	40035	Float	2	R	pH slope
Diagnostics	SoftwareVersion	40037	String	6	R	Software version
Diagnostics	SerialNumber	40043	String	6	R	Serial number
Diagnostics	pHOffset	40049	Float	2	R	pH offset
Diagnostics	OrpOffset	40051	Float	2	R	Orp offset
Calibration	CalCode	40053	Integer	1	R	Cal code
Configuration	SensorLogInterval	40054	Integer	1	R/W	Sensor data log interval
Configuration	TempLogInterval	40055	Integer	1	R/W	Temperature data log interval
Diagnostics	pHmV	40056	Float	2	R	pH mV
Diagnostics	ProdDate	40058	Date	2	R/W	Production date
Diagnostics	StdElectrode	40060	Float	2	R	Standard electrode impedance
Diagnostics	RefElectrode	40062	Float	2	R	Reference electrode impedance
Diagnostics	LastCalDate	40064	Date	2	R	Last calibration date
Diagnostics	SensorDays	40066	Integer	1	R	Sensor running days
Diagnostics	ElectrodeDays	40067	Integer	1	R	Electrode running days
Diagnostics	ElectrodeStatus	40068	Integer	1	R	Electrode status
Diagnostics	SensorType	40069	Integer	1	R	Sensor type
Configuration	RejectFrequency	40070	Integer	1	R/W	Reject frequency
Diagnostics	DeviceDriver	40071	String	5	R	Device driver
Configuration	CalWarningDays	40076	Integer	1	R/W	Calibration warning days
Configuration	SensorWarningDays	40077	Integer	1	R/W	Sensor warning days

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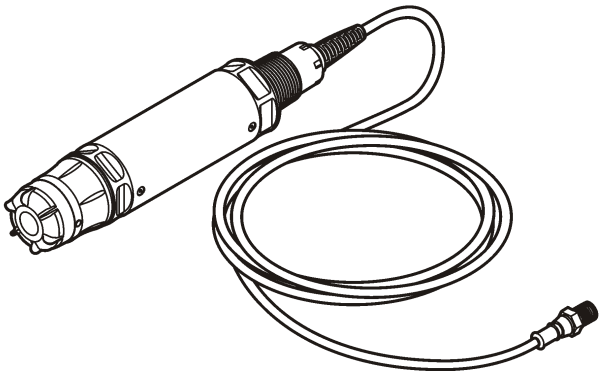
DOC023.97.80170

LDO Sensor

07/2012, Edition 2



USER MANUAL

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Specifications

Specifications are subject to change without notice.

Specification	Details
Wetted materials (probe body)	CPVC, sensor end and cable end
	Polyurethane, over-molding on cable end and cable jacket
	316 stainless steel body and screws
	Viton, O-ring
	Noryl, nut on the cable end
IP classification	IP68
Wetted materials (sensor cap)	Acrylic
Measurement range (dissolved oxygen)	0 to 20 ppm (0 to 20 mg/L)
	0 to 200% saturation
Measurement accuracy (dissolved oxygen)	Below 5 ppm: ± 0.1 ppm
	Above 5 ppm: ± 0.2 ppm
Repeatability (dissolved oxygen)	0.1 ppm (mg/L)
Response time (dissolved oxygen)	T_{90}<40 seconds
	T_{95}<60 seconds
Resolution, sensor (dissolved oxygen)	0.01 ppm (mg/L); 0.1% saturation.
Measurement range (temperature)	0 to 50 °C (32 to 122 °F)
Measurement accuracy (temperature)	± 0.2 °C (± 0.36 °F)
Interferences	No interferences from the following: H_2S, pH, K^+, Na^+, Mg^{2+}, Ca^{2+}, NH_4^+, Al^{3+}, Pb^{2+}, Cd^{2+}, Zn^{2+}, Cr (total), Fe^{2+}, Fe^{3+}, Mn^{2+}, Cu^{2+}, Ni^{2+}, Co^{2+}, CN^-, NO_3^-, SO_4^{2-}, S^{2-}, PO_4^{3-}, Cl^-, Anion Active Tensides, Crude Oils, Cl_2 < 4 ppm
Storage temperature	–20 to 70 °C (–4 to 158 °F)
Maximum ambient temperature	60 °C (140 °F). Suitable for use in water up to 50 °C (122 °F)
Hazardous location classification (5790001 sensor only)	Class I Division 2, Groups A–D, T4 / Class I, Zone 2 Group 2C, T4 ***Note:*** *This product does not fulfill the requirements of the 94/9/EC Directive (ATEX Directive).*
Certifications (5790001 sensor only)	ETL listed to ANSI/ISA, CSA and FM standards for use in hazardous location. ***Note:*** *This product does not fulfill the requirements of the 94/9/EC Directive (ATEX Directive).*
Minimum flow rate	Not required

Specification	Details
Calibration/verification	Air calibration: One point, 100% water-saturated air
	Sample calibration: Comparison with standard instrument
Probe immersion depth and pressure limits	Pressure Limits at 34 m (112 ft.), 345 kPa (50 psi) maximum; accuracy may not be maintained at this depth
Sensor cable	10 m (30 ft) integral cable with quick disconnect plug (all sensor types) Up to 100 m possible with extension cables (non-Class I, Division 2 sensor types only) Up to 1000 m with junction box (non-Class I, Division 2 sensor types only)
Probe weight	1.0 kg (2 lb, 3 oz)
Probe dimensions	Diameter x length: 49.3 x 255.7 mm (1.9 x 10.1 in.)
Power requirements	12 VDC, 0.25 A, 3 W
Warranty	Probe: 3 years against manufacturing defects
	Sensor cap: 2 years against manufacturing defects

General information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.

Safety information

NOTICE

The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

Use of hazard information

⚠ DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE
Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

	This is the safety alert symbol. Obey all safety messages that follow this symbol to avoid potential injury. If on the instrument, refer to the instruction manual for operation or safety information.
	This symbol indicates the presence of a light source that may have the potential to cause minor eye injury. Obey all messages that follow this symbol to avoid potential eye injury.
	This symbol indicates the presence of devices sensitive to Electro-static Discharge (ESD) and indicated that care must be taken to prevent damage with the equipment.
	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/98/EC), European electrical equipment users must now return old or end-of-life equipment to the Producer for disposal at no charge to the user. ***Note:*** *For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories, and all auxillary items for proper disposal.*

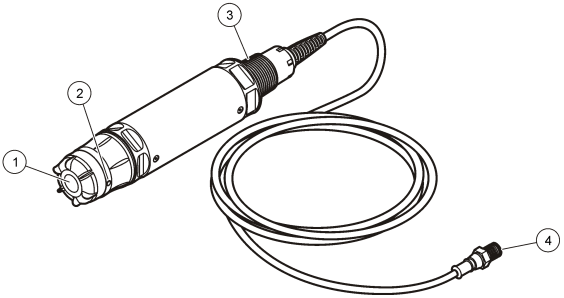
Product overview

⚠ DANGER
Chemical or biological hazards. If this instrument is used to monitor a treatment process and/or chemical feed system for which there are regulatory limits and monitoring requirements related to public health, public safety, food or beverage manufacture or processing, it is the responsibility of the user of this instrument to know and abide by any applicable regulation and to have sufficient and appropriate mechanisms in place for compliance with applicable regulations in the event of malfunction of the instrument.

This sensor is designed to work with a controller for data collection and operation. The sensor can be used with several controllers. Refer to the controller-specific user manual for more information.

The primary applications for this sensor are municipal and industrial wastewater applications. LDO sensor technology does not consume oxygen, and can measure DO concentration in low or no-flow applications. Refer to Figure 1.

Figure 1 LDO sensor

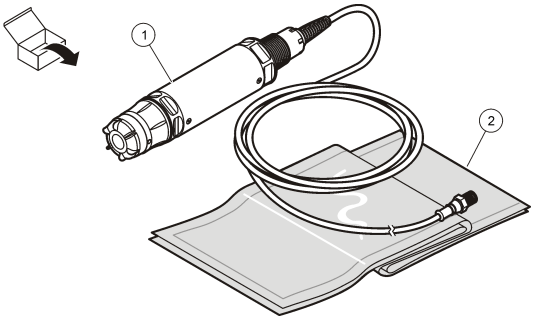


1 Sensor cap	**3** 1-inch NPT
2 Temperature sensor	**4** Connector, quick-connect (standard)

LDO Sensor component list

Make sure that all components shown in Figure 2 have been received. If any items are missing or damaged, contact the manufacturer or a sales representative immediately. Refer to Figure 2.

Figure 2 Sensor component list



1 LDO sensor[1]	**2** Calibration bags (2x)

[1] Included user manual is not shown.

Installation

Validate the sensor type

⚠ DANGER

Explosion hazard. Connect only peripheral components that are clearly marked as certified for Class 1, Division 2 Hazardous Locations.

NOTICE

The hazardous location certified version of this product does not fulfill the requirements of the 94/9/EC Directive (ATEX Directive).

1. Go to the connector end of the cable.
2. Read the label on the connector end of the cable. For hazardous location certified sensors, the label will show "Rated: Class 1 Division 2".

3. Examine the connector.
   - Hazardous location certified sensors have a safety lock connector. Refer to Figure 3 on page 7.
   - Sensors that are not certified for hazardous locations have a quick-connect connector, without a safety lock.

Connect the sensor in a hazardous location

⚠ DANGER

Explosion hazard. This equipment is suitable for use in non-hazardous locations or Class 1, Division 2, Groups A, B, C, D Hazardous Locations with specified sensors and options when installed per the Hazardous Location Installation Control Drawing. Always refer to the Control Drawing and applicable electrical code regulations for proper installation instructions.

⚠ DANGER

Explosion hazard. Do not connect or disconnect electrical components or circuits to the equipment unless power has been removed or the area is known to be non-hazardous.

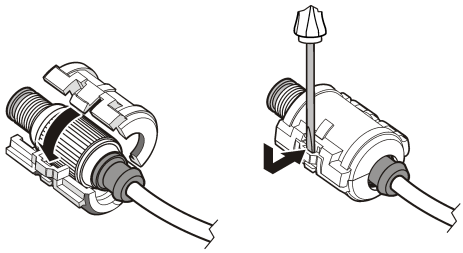
NOTICE

Use only a hazardous location certified sensor and cable lock in hazardous locations. The hazardous location certified version of this product does not fulfill the requirements of the 94/9/EC Directive (ATEX Directive).

For more information, refer to Validate the sensor type on page 6 .

1. Remove the connector cap from the controller. Keep the connector cap to seal the connector opening when the sensor is removed.
2. Connect the sensor to the controller. Refer to the controller manual for more information.
3. Close the safety lock over the connector.
4. To remove the connector safety lock, use a small flat screwdriver. Refer to Figure 3.

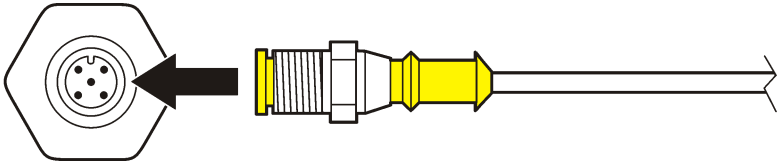
Figure 3 Connector safety lock



Connect the sensor in a non-hazardous location

Refer to Figure 4 to connect an LDO sensor to an sc controller. Refer to the specific sc controller manual for hard-wiring instructions.

Figure 4 Connect the LDO sensor (non-hazardous location sensor shown)



After the sensor is attached, scan for the sensor. Refer to Install the sensor on page 8.

Install the sensor

There are two options to install the sensor:

- Connect the sensor while power to the controller is off. The controller will look for and install new sensors when it is turned on.
- Connect the sensor while power to the controller is on. Use the Scan Devices command to install the new sensor:

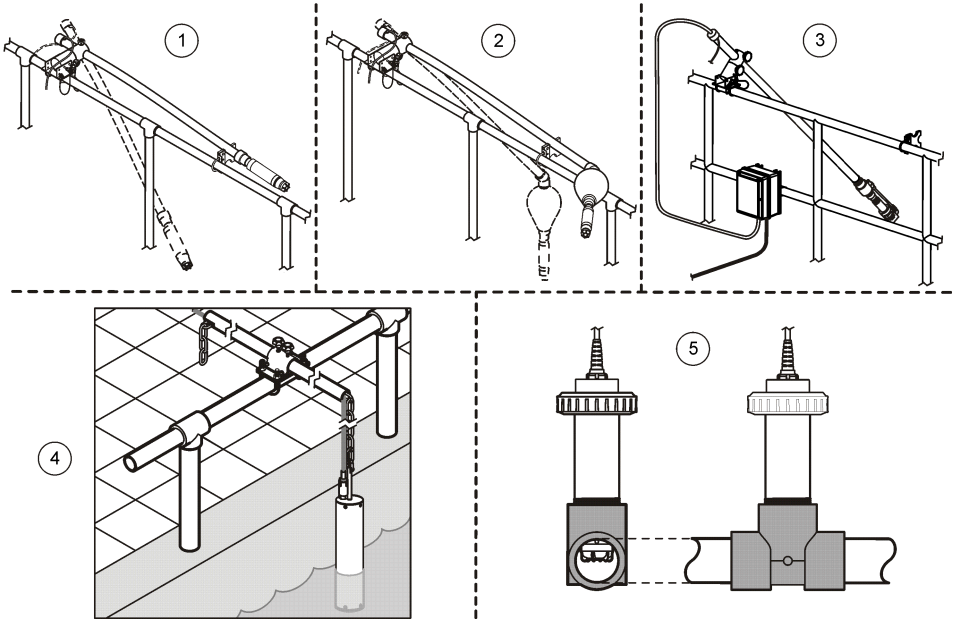
Option	Description
sc200 controller	Go to MENU>TEST/MAINT>SCAN DEVICE
sc100 controller	Go to MENU>TEST/MAINT>SCAN SENSORS
sc1000 controller	Go to MENU>SYSTEM SETUP>DEVICE MANAGEMENT>SCANNING FOR NEW DEVICES

Refer to Connect the sensor in a non-hazardous location on page 7 for digital sensor connection.

Sensor installation options

The installation and accessory options available for the LDO sensor are supplied with installation instructions in the hardware kit. Figure 5 shows several installation options. To order installation hardware, refer to Replacement parts and accessories on page 17.

Figure 5 Installation options



1 Rail mount	**4** Chain mount
2 Float mount	**5** Union mount
3 Air blast system mount	

Operation

User navigation

Refer to the controller documentation for keypad description and navigation information.

Configure the sensor

Use the Configure menu to enter identification information for the sensor and to change options for data handling and storage.

For information about sensor installation, refer to Install the sensor on page 8.

Make sure that all of the Configuration menu values are correct for the application.

1. Go to MENU>SENSOR SETUP>[Select Sensor]>CONFIGURE.
2. Select an option, ENTER. The list of available options is shown in the table below.

Option	Description
EDIT NAME	Changes the name that corresponds to the sensor on the top of the measure screen. The name is limited to 10 characters in any combination of letters, numbers, spaces or punctuation.
SET UNITS	TEMP–Sets the temperature units to °C (default) or °F.
	MEASURE–Set the measurement units in mg/L, ppm or % .
	ALT/PRESS–Set the altitude in m or ft, or set the atmospheric pressure units in mmHg or torr. (Default value = 0 ft)
ALT/PRESS	Enter the value of the altitude or atmospheric pressure. This value must be accurate to complete % saturation measurements and calibration in air. (Default = 0 ft).
SALINITY	Enter the salinity value. Salinity range: 0.00 to 250.00 parts per thousand (‰). Refer to Enter a salinity correction value on page 10 for more information. (Default value = 0)
SIGNAL AVERAGE	Set the time interval to average signal in seconds
CLEAN INTRVL	Set the time interval for manual sensor cleaning in days (Default value = 0 days. A value of 0 days disables the clean interval.)
RESET CLN INTRVL	Set the time interval to the last saved clean interval
LOG SETUP	Sets the time interval for data storage in the data log—0.5, 1, 2, 5, 10, 15 (default), 30, 60 minutes.
SET DEFAULTS	Restores the configurable default values for the sensor. Does not change the setting for slope or offset.

Enter the atmospheric pressure value

The factory setting for atmospheric (air) pressure is 0 ft, or sea level. To change the default value, use the steps in this procedure. The adjustment for air pressure is entered as either elevation or as pressure units (preferred).

Note: *Accurate air pressure is critical for saturated air calibration (Calibration with air on page 11). Use only absolute pressure, not adjusted. If the absolute air pressure is not known, use the correct elevation for the location.*

1. Go to MENU>SENSOR SETUP>[Select Sensor]>CONFIGURE>SET UNITS>AIR PRESS/ALT UNITS.
2. Select **one** of the unit options listed:

Option	Description
ft	Feet—unit of measure for elevation
m	Meters—metric unit of measure for elevation

Option	Description
mmHg	Millimeters of mercury—metric unit of measure for absolute air pressure
torr	Unit of measure for absolute air pressure

3. Confirm the selection. The value entry screen will show the selected units.
4. Enter the value, then confirm.

Enter a salinity correction value

Dissolved oxygen measurements in saline samples can show an apparent DO value that is very different from the actual DO value. To correct for the influence of dissolved salts in a sample, enter a salinity correction factor.

Note: *If the presence or amount of salinity in the process is unknown, consult with the treatment facility engineering staff.*

1. Use a conductivity meter to measure the conductivity of the sample in mS/cm at a reference temperature of 20 °C (68 °F).
2. Use Table 1 to estimate the salinity correction factor in parts per thousand (‰) saturation.

   Note: *The chloride ion concentration, in g/kg is equal to the chlorinity of the sample. Salinity is calculated with the formula: Salinity = 1.80655 × chlorinity.*

   Salinity can be calculated with the relationship in section 2520 B of *Standard Methods for the Examination of Water and Wastewater*.*,
3. Go to MENU>SENSOR SETUP>[Select Sensor]>CONFIGURE>SALINITY.
4. Enter the salinity correction factor and confirm.

Table 1 Salinity saturation (‰) per conductivity value (mS/cm)

mS/cm	‰	mS/cm	‰	mS/cm	‰	mS/cm	‰
5	3	16	10	27	18	38	27
6	4	17	11	28	19	39	28
7	4	18	12	29	20	40	29
8	5	19	13	30	21	42	30
9	6	20	13	31	22	44	32
10	6	21	14	32	22	46	33
11	7	22	15	33	23	48	35
12	8	23	15	34	24	50	37
13	8	24	17	35	25	52	38
14	9	25	17	36	25	54	40
15	10	26	18	37	26		

* *Standard Methods for the Examiniation of Water and Wastewater*, 20th Edition. Editors Lenore S. Clesceri, Arnold E. Greenberg and Andrew D. Eaton, p. 2-48-2-29 (1998). The relationship between Chlorinity and Oxygen Solubitity is provided in the same reference in 4500-O:I p. 4-131.

Configure linear output on the controller

Linear outputs send probe data back to the facility PLC, SCADA or other data collection system.

1. Go to the controller output setup menu.

Option	Description
sc200	Go to MENU>SETTINGS>sc200 SETUP>OUTPUT SETUP>[Select Output]>SET FUNCTION.
sc100	Go to MENU>SYSTEM SETUP>OUTPUT SETUP>[Select Output]>SET FUNCTION.
sc1000	Go to MENU>SYSTEM SETUP>OUTPUT SETUP>[Select Output]>SET FUNCTION.

2. Set the function for the controller.

Option	Description
sc200	LINEAR
sc100	LINEAR CONTROL (Default value)
sc1000	LINEAR CONTROL (Default value)

Modbus registers

A list of Modbus registers is available for network communication. Refer to www.hach.com or www.hach-lange.com for more information.

Calibration for measurements

The sensor is calibrated to specification at the factory. The manufacturer does not recommend calibration unless periodically required by regulatory agencies. If calibration is required, let the sensor come to equilibrium with the process before calibration. Do not calibrate the sensor at setup.

Table 2 shows options for calibration.

Table 2 Calibration options

Option	Description
AIR CAL	Recommended calibration method. This calibration modifies the slope.
SAMPLE CAL	Calibration by comparison with a hand-held DO meter . This calibration modifies the offset.
RESET DFLT CAL	Resets the calibration gain (slope) and offset to the factory default: default gain=1.0; default offset=0.0

Calibration with air

User notes:

- Make sure that calibration bag has water inside.
- Make sure that the seal between the calibration bag and the sensor body is tight.
- Make sure that the sensor is dry when it is calibrated.
- Make sure the air pressure/elevation setting is accurate for the calibration location.
- Allow enough time for the sensor temperature to stabilize to the temperature of the calibration bag location. A large difference in temperature between the process and the calibration location can take up to 15 minutes to stabilize.

1. Remove the sensor from the process. Use a wet cloth to clean the sensor.
2. Put the entire sensor in a calibration bag with 25-50 mL of water. Make sure that the sensor cap is not in contact with the water inside the calibration bag and that no water drops are on the sensor cap (Figure 6).
3. Use a rubber band, tie or hand to create a tight seal around the sensor body.

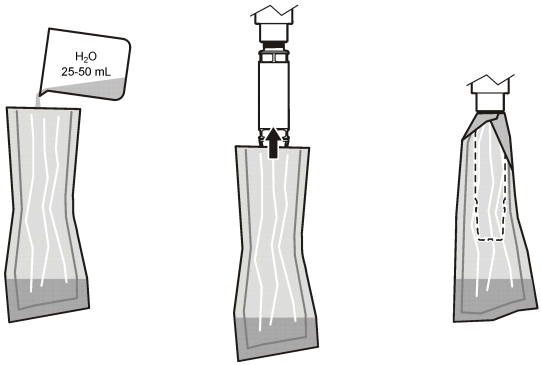
4. Let the instrument stabilize for 15 minutes before calibration. Keep the calibration bag out of direct sunlight during stablization.
5. Make sure that the current absolute air pressure or elevation is configured correctly. Refer to Enter the atmospheric pressure value on page 9.

   Note: *The manufacturer recommends the use of absolute or actual air pressure as a best practice.*
6. Go to MENU>SENSOR SETUP>[Select Sensor]>CALIBRATE>AIR CAL.
7. Select the option for the output signal during calibration:

Option	Description
Active	The instrument sends the current measured output value during the calibration procedure.
Hold	The sensor output value is held at the current measured value during the calibration procedure.
Transfer	A preset value is sent during calibration. Refer to the controller user manual to change the preset value.

8. The controller will show "Move the probe to bag". Allow the value to stabilize. Push ENTER to accept the stable value. Alternately, let the calibration continue until the display shows "Complete".
9. When the sensor is calibrated, put the sensor into the process. Push ENTER.

Figure 6 Air calibration procedure



If the value does not stabilize, the display will show "Unable to Calibrate" followed by an error message. Table 3 shows the error message and resolution for calibration problems.

Table 3 Air calibration error messages

Message	Description	Resolution
Cal fail, gain high	The calculated gain value is too high.	Repeat the calibration.
Cal fail, gain low	The calculated gain value is too low.	Repeat the calibration.
Cal fail, unstable	The value did not stabilize in the maximum allowed calibration time.	Repeat the calibration.

Sample CAL - calibration by comparison

This calibration method uses an alternate sensor attached to a hand-held meter.

1. Put the alternate sensor into the process. Put the second sensor as close as possible to the first sensor.
2. Wait for the DO value to stabilize .
3. On the controller for the first sensor, go to MENU>SENSOR SETUP>[Select Sensor]>CALIBRATE>SAMPLE CAL.

4. Select the option for the output signal during calibration:

Option	Description
Active	The instrument sends the current measured output value during the calibration procedure.
Hold	The sensor output value is held at the current measured value during the calibration procedure.
Transfer	A preset value is sent during calibration. Refer to the controller user manual to change the preset value.

5. The controller will show:
   - "Press ENTER when stabilized"
   - The current dissolved oxygen measurement
   - The current temperature measurement
6. When the measurement is stable, push ENTER. The display will show an entry screen.

   Note: *The measurement will usually stabilize in 2 to 3 minutes.*

If the value does not stabilize, the display will show "Unable to Calibrate" followed by an error message. Table 4 shows the error message and resolution for calibration problems.

Table 4 Sample cal error messages

Message	Description	Resolution
Cal fail, offset high	The calculated offset value is too high.	Repeat the calibration.
Cal fail, offset low	The calculated offset value is too low.	Repeat the calibration.
Cal fail, unstable	The value did not stabilize in the maximum allowed calibration time.	Repeat the calibration.

Exit the calibration procedure

1. During calibration, push the BACK key. Three options are shown:

Option	Description
ABORT	Stop the calibration. A new calibration must start from the beginning.
BACK TO CAL	Return to the current calibration.
LEAVE	Exit the calibration temporarily. Access to other menus is allowed while the calibration continues in the background. A calibration for a second sensor (if present) can be started. To return to the calibration, push the MENU key and select Sensor Setup, [Select Sensor].

2. Select one of the options. Confirm.

Reset calibration defaults

Calibration settings can be reset to the factory defaults. Gain and offset values are set to 1.0 and 0.0, respectively.

1. Go to MENU>SENSOR SETUP>[Select Sensor]>CALIBRATE>RESET CAL DEFLT.
2. The display will show a confirmation message. Confirm to reset the sensor to the factory default calibration curve.

Maintenance

⚠ DANGER

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

⚠ DANGER

Explosion hazard. Do not connect or disconnect electrical components or circuits to the equipment unless power has been switched off or the area is known to be non-hazardous.

⚠ DANGER

Explosion hazard. Substitution of components may impair suitability for Class 1, Division 2. Do not replace any component unless power has been switched off and the area is known to be non-hazardous.

NOTICE

The hazardous location certified version of this product does not fulfill the requirements of the 94/9/EC Directive (ATEX Directive).

Maintenance schedule

The maintenance schedule shows minimum intervals for regular maintenance tasks. Perform maintenance tasks more frequently for applications that cause electrode fouling.
Note: *Do not disassemble the probe for maintenance or cleaning.*

Maintenance task	Recommended minimum frequency
Clean the sensor	90 days
Inspect the sensor for damage	90 days
Calibrate the sensor	As recommended by regulatory agencies

Clean the sensor

Clean the exterior of the sensor with a soft, wet cloth.
Note: *If the sensor cap must be removed for cleaning, do not expose the interior of the cap to direct sunlight for extended periods of time.*

Set or change the clean interval

Application conditions may need shorter or longer durations between manual sensor cleanings. The default clean interval is 0 days. To change the interval, refer to the steps in this procedure.

1. Go to MENU>SENSOR SETUP>[Select Sensor]>CONFIGURE>CLEAN INTRVL.
2. Change the shown value as needed. Confirm the change.
   - To turn off the clean interval, set the value to '0'.

Change the sensor cap

⚠ WARNING

Potential explosion hazard. The sensor setup cap is not rated for hazardous location use.

Replacement sensor caps and setup caps are shipped with installation instructions. Refer to the included instructions to change the cap.

For best performance and accuracy, replace the sensor cap:

- Every two years
- When routine inspection shows significant erosion of the sensor cap

Troubleshooting

Diagnostic and test menu

The diagnostic and test menu shows current and historical information about the LDO sensor. To access the diagnostic and test menu, go to MENU>SENSOR SETUP>[Select Sensor]>DIAG/TEST.

Refer to Table 5.

Table 5 DIAG/TEST menu

Option	Description
SENSOR INFO	SOFTWARE VERS—Shows the installed software version
	BOOT VERSION—Shows the installed boot version
	DRIVER VERS—Shows the installed software driver version
LOT CODE	Shows the sensor cap manufacturing lot
SERIAL NUMBER	Sensor serial number
GAIN CORR	Adjust the calibration gain value.
	Range: 0.50 to 2.00
OFFSET CORR	Adjust the calibration offset value (mg/L or ppm).
	Range: –3.00 to +3.00
PHASE DIAG	Shows the phase for total, red and blue wavelengths. Updates once per second.
AMPL DIAG	Shows the amplitude for red and blue wavelengths. Updates once per second.
DAYS TO CLEAN	Shows the number of days until the next scheduled manual cleaning.
SENSOR LIFE	Shows the number of days until the next scheduled sensor cap replacement

Error list

If an error occurs, the reading on the measurement screen flashes. Output behavior is determined by controller settings. Refer to the controller manual for details.
To show the current sensor errors, go to MENU>DIAGNOSTICS>[Select Sensor]>ERROR LIST. Refer to Table 6.

Table 6 Error list for the LDO sensor

Error	Possible cause	Resolution
RED AMPL LOW (Value is below 0.01) OR BLUE AMPL LOW (Value is below 0.01)	The sensor cap is not installed, or is not installed correctly.	Remove the sensor cap and install it again.
	The light path is blocked in the sensor cap.	Inspect the inside of the sensor cap and lens.
	The sensor is not operating correctly.	Make sure that the LED is flashing. Contact the manufacturer.

Warning list

When the warning icon flashes (sc100 and sc200) or when the screen turns yellow (sc1000), a message is shown on the bottom of the measurement screen. On the sc1000, the screen turns

yellow to show a warning. To show the current sensor warnings, go to MENU> DIAGNOSTICS>[Select Sensor]>WARNING LIST. Refer to Table 7.

Table 7 Sensor warning list

Warning	Definition	Resolution
EE SETUP ERR	Storage is corrupt. The values have been set to the factory default.	Contact technical support.
EE RSRVD ERR		
TEMP < 0 C	The process temperature is below 0 °C (32 °F)	Increase the process temperature or stop use until the process temperature is in the sensor specification range.
TEMP > 50 C	The process temperature is above 50 °C (120 °F)	Decrease the process temperature or stop use until the process temperature is in the sensor specification range.
RED AMPL LOW	Value falls below 0.03	Refer to Table 6 on page 15 .
RED AMPL HIGH	Value is greater than 0.35	Call technical support.
BLUE AMPL LOW	Value is below 0.03	Refer to Table 6 on page 15.
BLUE AMPL HIGH	Value is greater than 0.35	Call technical support.
CAP CODE FAULT	The sensor cap code has become corrupt. The code has been reset automatically to the default cap and lot codes.	Complete the sensor setup cap procedure. If no setup cap is available for the sensor cap, call technical support.

Event list

The Event list keeps a log of changes to how data is recorded by the sensor. To show sensor events, go to MENU>DIAGNOSTICS>[Select Sensor]>EVENT LIST.
Refer to Table 8.

Table 8 Event list for the sensor

Event	Description
ALT/PRESSURE UNIT CHANGE	Atmospheric pressure or altitude units have changed.
ALT/PRESSURE CHANGE	The value for altitude or atmospheric pressure has changed.
TEMP UNIT CHANGE	The units for temperature have changed.
MEAS UNIT CHANGE	A new unit of measurement has changed.
SALINITY CHANGE	The value for salinity has changed.
SET DEFAULT	Sensor settings have been reset to the default values.
SENSOR SETUP CHANGE	The sensor setup has changed.
CLEAN INTERVAL TIMER CHANGE	The time between sensor cleaning has changed.
SENSOR CAP LIFE TIMER CHANGE	The time between sensor cap replacements has changed.

Replacement parts and accessories

Replacement items

Description	Item no. (US / EU)
LDO Probe, with one sensor cap and 2 calibration bags	9020000 / LXV416.99.20001
LDO Probe for hazardous locations, with one sensor cap and 2 calibration bags	9020300 / —
Sensor cap, replacement (includes the sensor setup cap, which is not rated for use in Class 1, Division 2 hazardous locations)	9021100 / 9021150

Accessories

Description	Item no. (US / EU)
Sensor cable lock for hazardous locations	6139900 / —
High output air blast cleaning system, 115 V (not rated for use in hazardous locations)	6860000 / 6860003.99.0001
High output air blast cleaning system, 230 V (not ATEX rated for use in hazardous locations)	6860100 / 6860103.99.0001
Calibration bag (1x)	5796600 / 5796600
Cable, sensor extension, non-hazardous location, 7.7 m (25 ft)[1]	US: 5796000, 7.7 m (25 ft)
	EU: LZX849, 10 m (33 ft)
Hardware kit for pipe mount (PVC)	9253000 / LZY714.99.21810
Hardware kit for float mount (PVC)	9253100 / LZX914.99.42200
Hardware kit for air blast mount	9253500 / LZY812
Hardware kit for chain mount (stainless steel)	— / LZX914.99.11200
Hardware kit for union mount	9257000 / 9257000
HQd meter with LDO rugged probe (not rated for use in hazardous locations)	8505200 / HQ40D.99.310.000

[1] 15 m (49 ft) and 30 m (98 ft) also available

User Manual

Allen-Bradley

ControlLogix System User Manual

Catalog Numbers 1756-L61, 1756-L62, 1756-L63, 1756-L63XT, 1756-L64, 1756-L65, 1756-L71, 1756-L72, 1756-L73, 1756-L73XT, 1756-L74, 1756-L75

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation® sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
	SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Allen-Bradley, CompactLogix, ControlLogix, DriveLogix, FLEX, Kinetix, MessageView, MicroLogix, POINT I/O, PhaseManager, PowerFlex, RSFieldbus, RSLinx, RSLogix, RSNetWorx, Rockwell Software, Rockwell Automation, Compact I/O, RediSTATION, Series 9000, FlexLogix, PanelView, FactoryTalk, ArmorPOINT, Stratix 8000, SLC, ControlFLASH, DH+, Data Highway Plus, Integrated Architecture, Logix5000, ControlLogix-XT, GuardLogix, RSView, Encompass, 1336 FORCE, 1336 PLUS, 1336 IMPACT, SMC, RSBizWare, FLEX Ex, ArmorBlock, ArmorBlock MaXum, Guard PLC, and TechConnect are trademarks of Rockwell

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This manual contains new and updated information. Changes throughout this revision are marked by change bars, as shown to the right of this paragraph.

New and Updated Information

This table contains the changes made to this revision.

Topic	Page
Studio 5000™ Logix Designer application is the rebranding of RSLogix™ 5000 software	11
Added an Attention statement to the section about installing the ESM	25
Added Integrated Motion to motion control options	141
Added section about extended properties	154

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Preface

Studio 5000 Environment

The Studio 5000™ Engineering and Design Environment combines engineering and design elements into a common environment. The first element in the Studio 5000 environment is the Logix Designer application. The Logix Designer application is the rebranding of RSLogix™ 5000 software and will continue to be the product to program Logix5000™ controllers for discrete, process, batch, motion, safety, and drive-based solutions.

The Studio 5000 environment is the foundation for the future of Rockwell Automation® engineering design tools and capabilities. It is the one place for design engineers to develop all the elements of their control system.

ControlLogix Controllers Overview

There are three types of ControlLogix® controllers available. These types include the following:

- Standard ControlLogix controllers
- Extreme environment ControlLogix controller
- Safety GuardLogix® controllers

This manual explains how to use standard and extreme environment ControlLogix controllers.

For more information about using safety GuardLogix controllers, see the GuardLogix Controller Systems Safety Reference Manual, publication 1756-RM093, or the GuardLogix Controllers User Manual, publication 1756-UM020.

Standard ControlLogix Controllers

Two lines of standard ControlLogix controllers are now available. These controllers are identified as 1756-L6*x* controllers and 1756-L7*x* controllers according to abbreviations of their full catalog numbers.

Table 1 - ControlLogix Catalog Numbers

Abbreviated Cat. No.	Cat. No.
1756-L6*x*	1756-L61, 1756-L62,1756-L63, 1756-L64,1756-L65
1756-L7*x*	1756-L71, 1756-L72, 1756-L73,1756-L74, 1756-L75

The standard ControlLogix controllers share many similar features, but also have some differences. Table 2 provides a brief overview the differences between the controllers. For further details about these features and differences, see the appropriate chapters of this manual.

Table 2 - Differences Between 1756-L7*x* and 1756-L6*x* Controllers

Feature	1756-L7*x*	1756-L6*x*
Clock support and backup used for memory retention at powerdown	Energy Storage Module (ESM)	Battery
Communication ports (built-in)	USB	Serial
Connections, controller	500	250
Memory, nonvolatile	Secure Digital (SD) card	CompactFlash card
Status display and status indicators	Scrolling status display and four status indicators	Six status indicators
Unconnected buffer defaults	20 (40, max)	10 (40, max)

Redundant ControlLogix Controllers

Certain ControlLogix controllers are also supported for use in redundant systems. For more information about controllers and redundant systems, see Chapter 12.

Extreme Environment ControlLogix Controllers

The extreme environment ControlLogix controllers, catalog numbers 1756-L73XT and 1756-L63XT, provide the same functionality as the 1756-L73 and 1756-L63 controllers, but are designed to withstand temperatures -25...70 °C (-13...158 °F).

Before You Begin

Before you begin using your ControlLogix controller, verify that you have the applications required to configure and program the controller.

Required Software

Use this table to identify the minimum software versions required to use your ControlLogix controller.

Table 3 - Required Software for Controller Use

Cat. No.	Studio 5000 Environment	RSLogix 5000 Software	RSLinx® Classic
1756-L61/A	—	Version 12.06.00 or later	Any version
1756-L61/B	—	Version 13.04.00 or later	
1756-L62/A	—	Version 12.06.00 or later	
1756-L62/B	—	Version 13.04.00 or later	
1756-L63/A	—	• If not using a CompactFlash card, version 10.07.00 or later • If using a CompactFlash card, version 11.16.00 or later	
1756-L63/B	—	Version 13.04.00 or later	
1756-L63XT/B	—	Version 13.04.00 or later	Version 2.55.00 or later
1756-L64/B	—	Version 16.03.00 or later	Any version
1756-L65/B	—	Version 17.01.02 or later	
1756-L71/A	Version 21.00.00 or later	Version 20.01.02	Version 2.59.00 or later
1756-L72/A	Version 21.00.00 or later	Version 19.01.00 or later	Version 2.57.00 or later
1756-L73/A	Version 21.00.00 or later	Version 19.01.00 or later	
1756-L73XT/A	Version 21.00.00 or later	Version 19.01.00 or later	
1756-L74/A	Version 21.00.00 or later	Version 19.01.00 or later	
1756-L75/A	Version 21.00.00 or later	Version 19.01.00 or later	

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
1756 ControlLogix Controllers Technical Data, publication 1756-TD001	Provides specifications for ControlLogix controllers.
1756 ControlLogix I/O Modules Technical Data, publication 1756-TD002	Provides specifications for ControlLogix I/O modules.
ControlLogix Peer I/O Control Application Technique, publication 1756-AT016	Describes typical peer control applications and provides details about how to configure I/O modules for peer control operation.
Integrated Architecture and CIP Sync Configuration Application Technique, publication IA-AT003	Describes how to configure CIP Sync with Integrated Architecture™ products and applications.
ControlLogix Chassis and Power Supplies Installation Instructions, publication 1756-IN005	Describes how to install and troubleshoot standard and ControlLogix-XT™ versions of the 1756 chassis and power supplies, including redundant power supplies.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://ab.com	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at http://www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Install the 1756-L7*x* Controller

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ATTENTION: Personnel responsible for the application of safety-related programmable electronic systems (PES) shall be aware of the safety requirements in the application of the system and shall be trained in using the system.

ATTENTION: Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is not intended for use in residential environments and may not provide adequate protection to radio communication services in such environments.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA or be approved for the application if nonmetallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, Rockwell Automation publication 1770-4.1, for additional installation requirements
- NEMA Standard 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by enclosure

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	**Informations sur l'utilisation de cet équipement en environnements dangereux.**
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.
WARNING: EXPLOSION HAZARD • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**WARNING: RISQUE D'EXPLOSION** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

The following applies when the product bears the Ex Marking.
This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in Zone 2 potentially explosive atmospheres, given in Annex II to this Directive. Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15 and EN 60079-0.

ATTENTION: This equipment is not resistant to sunlight or other sources of UV radiation.

WARNING:

- This equipment shall be mounted in an ATEX certified enclosure with a minimum ingress protection rating of at least IP54 (as defined in IEC60529) and used in an environment of not more than Pollution Degree 2 (as defined in IEC 60664-1) when applied in Zone 2 environments. The enclosure must utilize a tool removable cover or door.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- This equipment must be used only with ATEX certified Rockwell Automation backplanes.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.

Before You Begin

Complete these tasks using the appropriate resources listed as references before you install your controller and power supply.

Task	Resources
Install a ControlLogix Chassis and Power Supply	Refer to ControlLogix Chasis and Power Supplies, publication 1756-IN005

1756-L7*x* Controller Parts

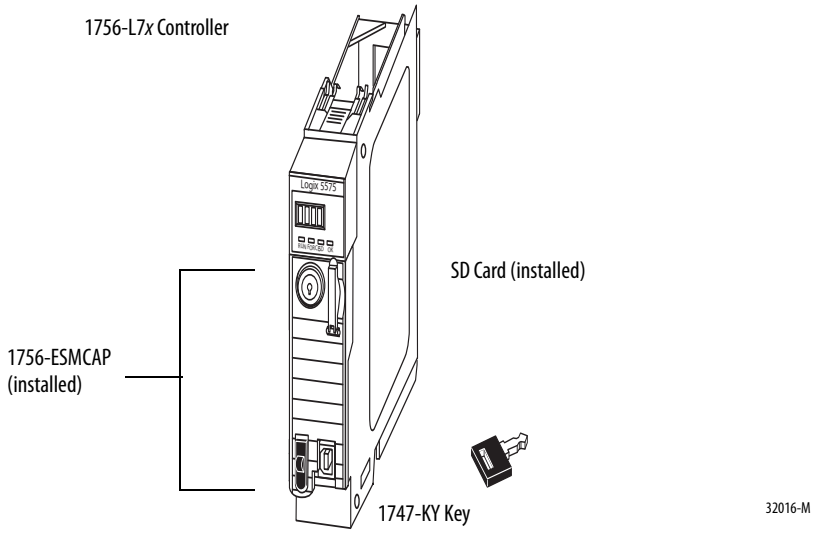
These sections describe parts that are included with the L7*x* controllers, as well as available accessory parts.

Parts Included with the 1756-L7*x* Controller

These parts are included with the controller:

- 1756-ESMCAP capacitor-based energy storage module (ESM)
- 1784-SD1 Secure Digital (SD) card, 1 GB
- 1747-KY controller key

Figure 1 - Parts with the 1756-L7*x* Controller



IMPORTANT The 1756-L7*x* controllers ship with an SD card installed. We recommend that you leave the SD card installed.

Parts Available for Use with the 1756-L7*x* Controller

In addition to parts included with the controller, you may choose to use these parts specific to your application.

If your application requires	Then use this part
USB connection from a computer to the controller	USB cable(1)
Nonvolatile memory	1784-SD1 (1 GB) or 1784-SD2 (2 GB)
ESM without WallClockTime back-up power	1756-ESMNSE This ESM does not have WallClockTime back-up power. Use this ESM if your application requires that the installed ESM deplete its residual stored energy to 40 µJoule or less before transporting it into or out of your application.(2) Additionally, you can use this ESM with a 1756-L73 (8 MB) or smaller memory-sized controller only.
ESM that secures the controller by preventing the USB connection and SD card use(2) This ESM provides your application an enhanced degree of security.	1756-ESMNRM

(1) The USB port is intended for temporary local programming purposes only and not intended for permanent connection. The USB cable is not to exceed 3.0 m (9.84 ft) and must not contain hubs.

(2) For information about the hold-up time of the ESMs, see Hold-up Time (in days) on page 71 and stored energy depletion rate on page 26.

WARNING: Do not use the USB port in hazardous locations.

ATTENTION:

- The USB port is intended for temporary local programming purposes only and not intended for permanent connection.
- The USB cable is not to exceed 3.0 m (9.84 ft) and must not contain hubs.

1756-L7*x* Controller Installation

These sections explain how to install the 1756-L7*x* controller. To install the 1756-L7*x* controller, complete the tasks summarized in this table.

✓	Task	Page
	Insert the Controller into the Chassis	19
	Insert the Key	20
	Remove the SD Card	21
	Install the SD Card	21
	Install the ESM	25

Insert the Controller into the Chassis

When installing a ControlLogix controller, you can do the following:

- Place the controller in any slot.
- Use multiple controllers in the same chassis.

You can install or remove a ControlLogix controller while chassis power is on and the system is operating.

WARNING: When you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electrical arcing causes excessive wear to contacts on both the controller and its mating connector on the chassis. Worn contacts may create electrical resistance that can affect controller operation.

ATTENTION: Prevent Electrostatic Discharge

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

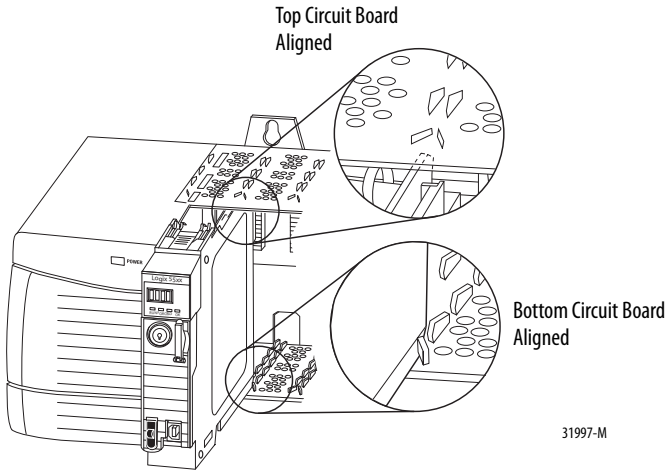
IMPORTANT

The ESM begins charging when one of these actions occurs:

- The controller and ESM are installed into a powered chassis.
- Power is applied to the chassis that contains a controller with the ESM installed.
- An ESM is installed into a powered controller.

After power is applied, the ESM charges for up to two minutes as indicated by CHRG or ESM Charging on the status display.

1. Align the circuit board with the top and bottom guides in the chassis.

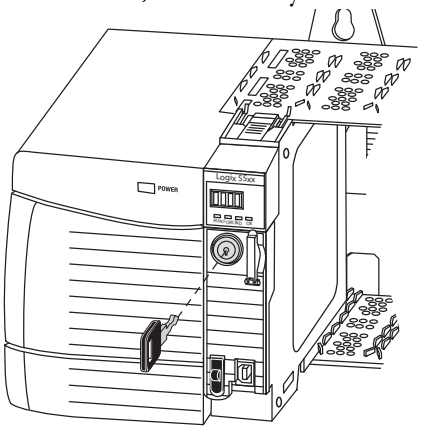


2. Slide the module into the chassis until it snaps into place.
3. Verify that the controller is flush with the power supply or other installed modules.

After you have inserted the controller into the chassis, reference the Status Indicators on page 185 for information about interpreting the status indicators.

Insert the Key

After the controller is installed, insert the key.



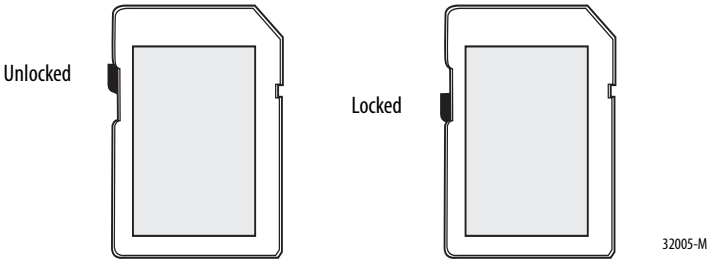
Install the SD Card

Complete these steps to install the SD card in the 1756-L7*x* controllers.

WARNING: When you insert or remove the Secure Digital (SD) memory card while power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

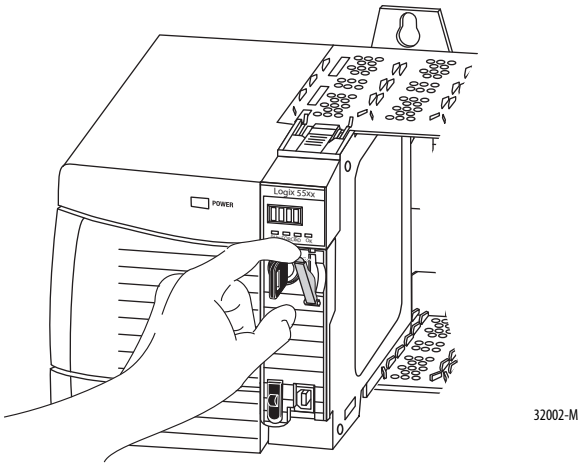
Be sure that power is removed or the area is nonhazardous before proceeding.

1. Verify that the SD card is locked or unlocked according to your preference.



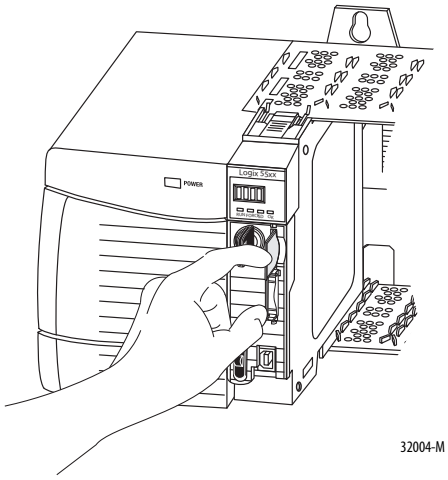
For more information about the lock/unlock memory settings, see the Load or Store to the Memory Card on page 64.

2. Open the door for the SD card.



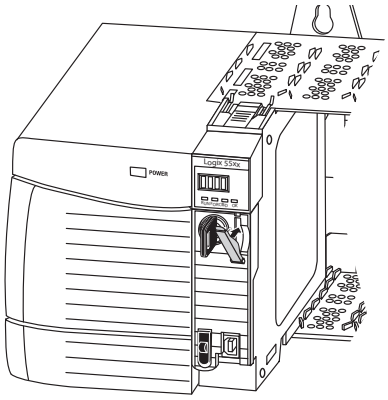
3. Insert the SD card into the SD card slot.

4. Gently press the card until it clicks into place.



32004-M

5. Close the SD card door.



32006-M

Remove the SD Card

The 1756-L7*x* controller ships with an SD card installed. Complete these steps to remove the SD card from the 1756-L7*x* controller.

WARNING: When you insert or remove the Secure Digital (SD) memory card while power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

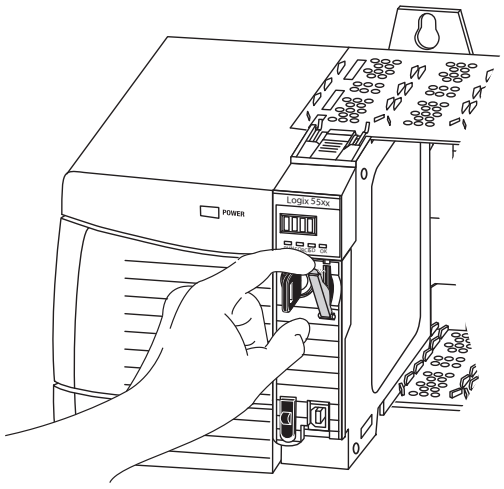
IMPORTANT

- Verify that the SD card status indicator is off and that the card is not in use before removing it.
- We recommend that you do the following:
  –Leave an SD card installed.
  – Use the SD cards available from Rockwell Automation (catalog number 1784-SD1 or 1784-SD2).
- While other SD cards may be used with the controller, Rockwell Automation has not tested the use of those cards with the controller. If you use an SD card other than those available from Rockwell Automation, you may experience data corruption or loss.
- Also, SD cards not provided by Rockwell Automation do not have the same industrial, environmental, and certification ratings as those available from Rockwell Automation.

1. Verify that the SD card is not in use by checking to be sure the SD indicator is Off.

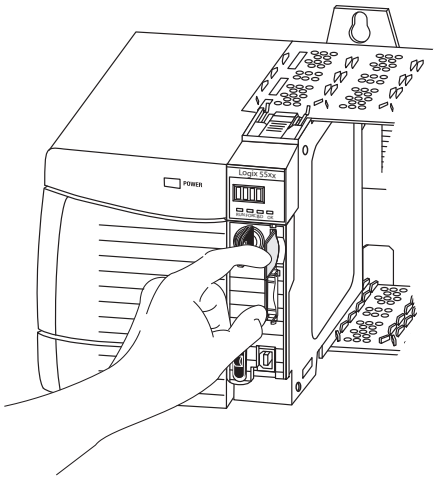
   TIP You may also put the controller into Hard Run mode to keep the controller from writing to the SD card while it is removed.

2. Open the door to access the SD card.



32015-M

3. Press and release the SD card to eject it.



32004-M

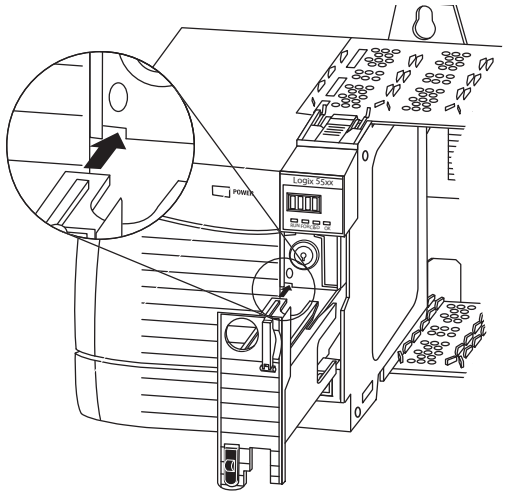
4. Remove the SD card and close the door.

Install the ESM

To install an ESM in the 1756-L7*x* controller, complete these steps.

ATTENTION: To avoid potential damage to the product when inserting the ESM, align it in the track and slide forward with minimal force until the ESM snaps into place.

1. Align the tongue-and-groove slots of the ESM and controller.



2. Slide the ESM back until it snaps into place.

   The ESM begins charging after installation. Charging status is indicated by one of these status messages:

   - ESM Charging
   - CHRG

   After you install the ESM, it may take up to 15 seconds for the charging status messages to display.

IMPORTANT Allow the ESM to finish charging before removing power from the controller. Failure to do so can result in the loss of the application program. A type 1, code 40 major fault will be logged on powerup.

To verify that the ESM is fully charged, check the status display to confirm that messages CHRG or ESM charging are no longer indicated.

TIP We recommend that you check the WallClockTime object attributes after installing an ESM to verify that time of the controller is correct.

The ESM contains a real-time clock. If the ESM is new or came from another controller, your controller's WallClockTime object attributes may change.

Uninstall the ESM

WARNING: If your application requires the ESM to deplete its residual stored energy to 40 µJoule or less before you transport it into or out of the application, use the **1756-(SP)ESMNSE(XT)** module only. In this case, complete these steps before you remove the ESM.

1. Turn power off to the chassis.
   After you turn power off to the chassis, the controller's OK status indicator transitions from green to solid red to OFF.
2. Wait **at least 20 minutes** for the residual stored energy to decrease to 40 µJoule or less before you remove the ESM.
   There is no visual indication of when the 20 minutes has expired. **You must track that time period**.

WARNING: When you insert or remove the energy storage module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector.

IMPORTANT Before you remove an ESM, make necessary adjustments to your program to account for potential changes to the WallClockTime attribute.

Consider these points before removing the ESM:

- The following ESM modules may be currently installed in your 1756-L7*x* or 1756-L7*x*XT controller:
  - 1756-ESMCAP
  - 1756-ESMNSE
  - 1756-ESMCAPXT
  - 1756-ESMNSEXT
- The 1756-L7*x* controllers come with the 1756-ESMCAP module already installed. The 1756-L7*x*XT extreme temperature controller ships with a 1756-ESMCAPXT module already installed. For more information on how to use a 1756-ESMNSE, 1756-ESMNRM, 1756-ESMNSEXT, or 1756-ESMNRMXT module, see page 25.
- After the 1756-L7*x* or 1756-L7*x*XT controllers lose power, either because the chassis power is turned off or the controller has been removed from a powered chassis, do not remove the ESM immediately.

  Wait until the controller's OK status indicator transitions from Green to Solid Red to OFF before you remove the ESM.
- You can use the 1756-ESMNSE module with a 1756-L73 (8MB) or smaller memory-sized controller only.

- Use the 1756-ESMNSE module if your application requires that the installed ESM deplete its residual stored energy to 40 µJoule or less before transporting it into or out of your application.
- Once it is installed, you cannot remove the 1756-ESMNRM or 1756-ESMNRMXT module from a 1756-L7*x* or 1756-L7*x*XT controller.

Complete these steps to remove an ESM module from the controller.

1. Remove the key from the mode switch.

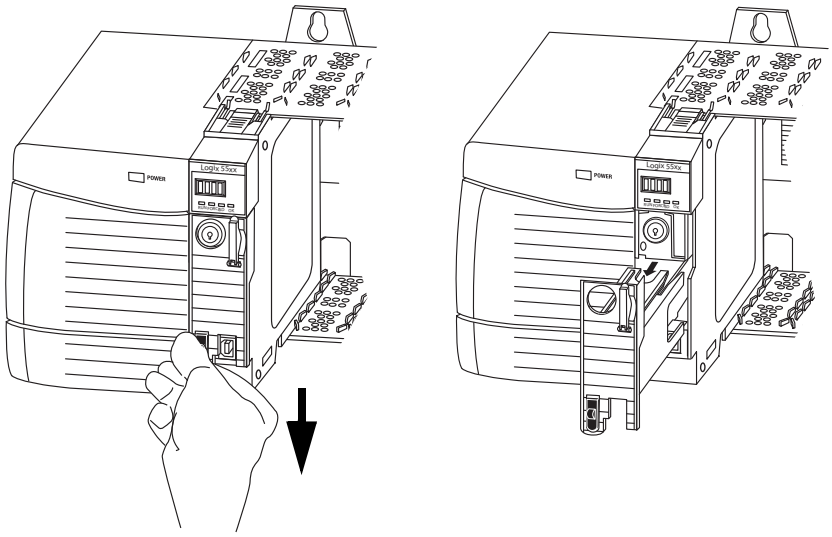
IMPORTANT The next step depends on which of the following conditions applies to your application.

- If you are removing the ESM from a powered 1756-L7*x* controller, go to step 2.
- If you are removing the ESM from a 1756-L7*x* controller that is not powered, either because the chassis power is turned off or the controller has been removed from a powered chassis, **do not remove** the ESM immediately.

  Wait until the controller's OK status indicator transitions from Green to Solid Red to OFF before you remove the ESM.

  After the OK status indicator transitions to Off, go to step 2.

2. Use your thumb to press down on the black release and pull the ESM away from the controller.



ControlLogix System and Controllers

Topic	Page
ControlLogix System	77
Design a ControlLogix System	80
ControlLogix Controller Features	81

ControlLogix System

The ControlLogix system is chassis-based and provides the option to configure a control system that uses sequential, process, motion, and drive control in addition to communication and I/O capabilities.

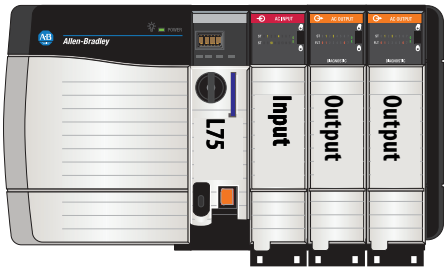
Configuration Options

This section describes some of the many system configuration options that are available with ControlLogix controllers.

Standalone Controller and I/O

One of the simplest ControlLogix configurations is a standalone controller with I/O assembled in one chassis.

Figure 7 - Standalone Controller and I/O

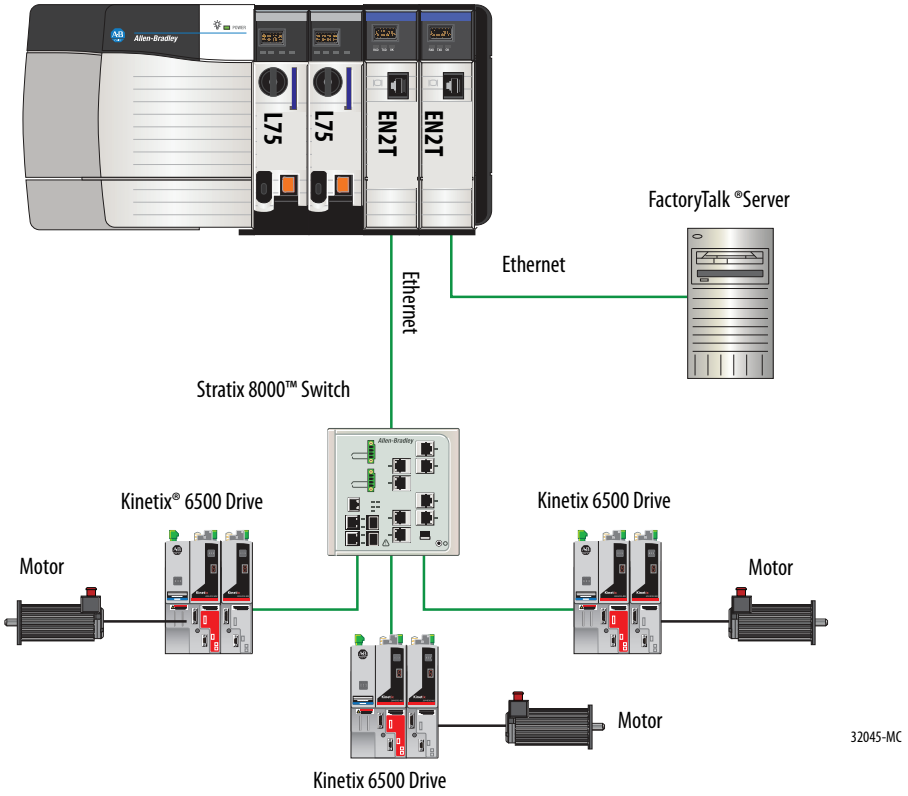


32044-MC

Multiple Controllers in One Chassis

For some applications, multiple controllers may be used in one ControlLogix chassis. For example, for better performance, multiple controllers can be used in motion applications.

Figure 8 - Multiple Controllers in One Chassis

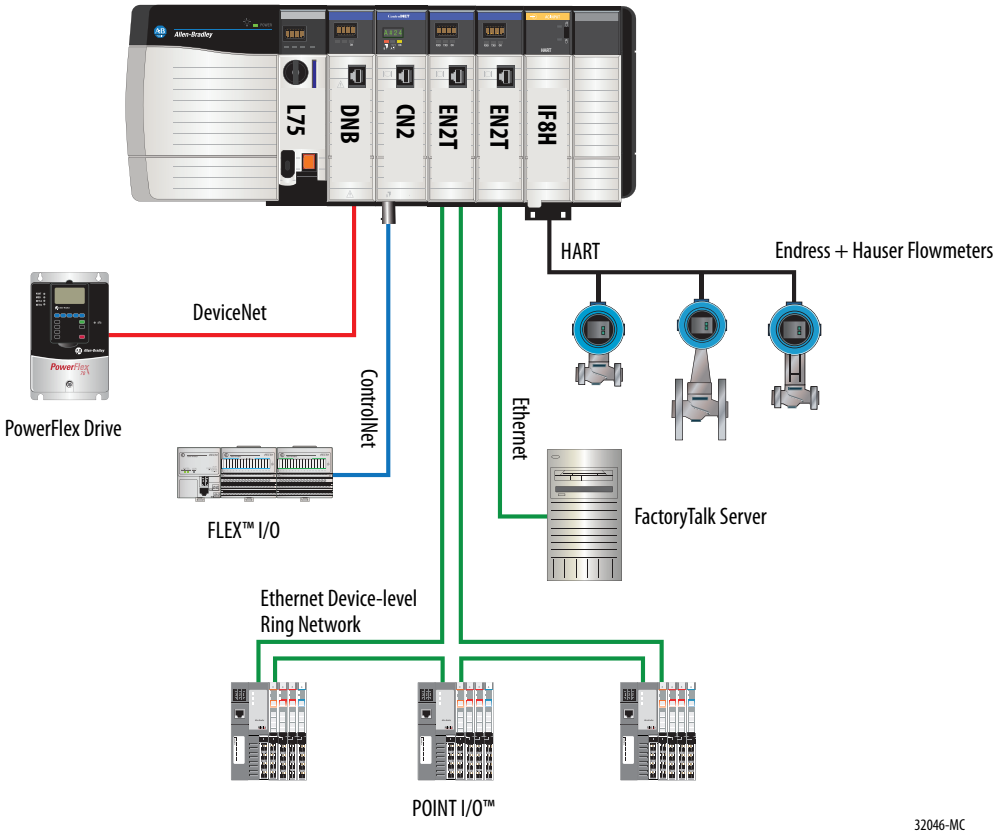


Multiple Devices Connected via Multiple Networks

For some applications, a variety of devices may be connected to the ControlLogix chassis via multiple communication networks. For example, a system might be connected to the following:

- Distributed I/O via an Ethernet network
- A PowerFlex® drive connected via a DeviceNet network
- Flowmeters connected via a HART connection

Figure 9 - Multiple Devices Connected via Multiple Networks



Design a ControlLogix System

When you design a ControlLogix system, there are several system components to consider for your application. Some of these components include the following:

- I/O devices
- Motion control and drive requirements
- Communication modules
- Controllers
- Chassis
- Power supplies
- Studio 5000 environment

For more information about designing and selecting components for your ControlLogix system, see the ControlLogix Selection Guide, publication 1756-SG001.

In addition, if you are designing your ControlLogix System for any of the specific applications listed in this table, see the appropriate resources for more information.

For this type of application	See this publication
Motion with Integrated Motion on the EtherNet/IP network	Integrated Motion on the EtherNet/IP Network Configuration and Startup User Manual, publication MOTION-UM003
Motion with the use of a coordinate system	Motion Coordinated Systems User Manual, publication MOTION-UM002
Motion with Sercos or analog motion	SERCOS Motion Configuration and Startup User Manual, publication MOTION-UM001
Enhanced redundancy	ControlLogix Enhanced Redundancy System User Manual, publication 1756-UM535
Standard redundancy	ControlLogix Redundancy System User Manual, publication 1756-UM523
SIL2	Using ControlLogix in SIL2 Applications Safety Reference Manual, publication 1756-RM001
SIL2 fault-tolerant I/O with RSLogix 5000 subroutines	ControlLogix SIL2 System Configuration Using RSLogix 5000 Subroutines Application Technique, publication 1756-AT010
SIL2 fault-tolerant I/O with RSLogix 5000 Add-On Instructions	ControlLogix SIL2 System Configuration Using SIL2 Add-On Instructions Application Technique, publication 1756-AT012

ControlLogix Controller Features

The ControlLogix controllers are part of the Logix5000 family of controllers offered by Rockwell Automation. The sections that follow describe the differentiating features of the ControlLogix controllers.

System, Communication, and Programming Features

This table lists the system, communication, and programming features available with ControlLogix controllers.

Table 11 - ControlLogix Controller Features

Feature	1756-L61, 1756-L62, 1756-L63, 1756-L64, 1756-L65	1756-L71, 1756-L72, 1756-L73, 1756-L74, 1756-L75
Controller tasks	• 32 tasks • 100 programs/task • Event tasks: all event triggers	
Communication ports	1 port - RS-232 serial	1 port - USB, 2.0 full-speed, Type B
Communication options	• EtherNet/IP • ControlNet • DeviceNet • Data Highway Plus™ • Remote I/O • SynchLink • Third-party process and device networks	
Serial port communication	• ASCII • DF1 full/half-duplex • DF1 radio modem • DH-485 • Modbus via logic	N/A
Controller connections supported, max	250	500
Network connections, per network module	• 100 ControlNet (1756-CN2/A) • 40 ControlNet (1756-CNB) • 256 EtherNet/IP; 128 TCP (1756-EN2*x*) • 128 EtherNet/IP; 64 TCP (1756-ENBT)	
Controller redundancy	Full support except for motion applications	
Integrated motion	• Integrated Motion on the EtherNet/IP network • SERCOS interface • Analog options: – Encoder input – LDT input – SSI input	
Programming languages	• Relay ladder • Structured text • Function block • Sequential Function Chart (SFC)	

Memory Options

The ControlLogix controller is available in different combinations of user memory. Use this table to determine which controller meets your memory requirements.

Table 12 - ControlLogix Controller Memory Options

Controller	Memory for Data and Logic	I/O	Back-up Memory
1756-L61	2 MB	478 KB	CompactFlash card(1)
1756-L62	4 MB		
1756-L63, 1756-L63XT	8 MB		
1756-L64	16 MB		
1756-L65	32 MB		
1756-L71	2 MB	0.98 MB (1006 KB)	SD card
1756-L72	4 MB		
1756-L73, 1756-L73XT	8 MB		
1756-L74	16 MB		
1756-L75	32 MB		

(1) These nonvolatile memory cards are optional and do not come with the controller.

IMPORTANT The 1756-L7*x* controllers ship with an SD card installed. We recommend that you leave the SD card installed, so if a fault occurs, diagnostic data is automatically written to the card and can be used by Rockwell Automation to troubleshoot the anomaly.

IMPORTANT We recommend that you use the SD cards available from Rockwell Automation (catalog numbers 1784-SD1 or 1784-SD2).

While other SD cards may be used with the controller, Rockwell Automation has not tested the use of those cards with the controller. If you use an SD card other than those available from Rockwell Automation, you may experience data corruption or loss.

Also, SD cards not provided by Rockwell Automation may not have the same industrial, environmental, and certification ratings as those available from Rockwell Automation and may not survive in the same industrial environments as the industrially rated versions available from Rockwell Automation.

Communication Networks

Topic	Page
Networks Available	83
EtherNet/IP Network Communication	84
ControlNet Network Communication	87
DeviceNet Network Communication	90
Data Highway Plus (DH+) Network Communication	92
Universal Remote I/O (RIO) Communication	94
Foundation Fieldbus Communication	96
HART Communication	97

Networks Available

Several communication networks are available for use with ControlLogix systems. This table describes typical network applications used with ControlLogix systems and lists the networks available to support such applications.

Table 13 - Applications and Supported Networks

Application Type	Supported Networks
Integrated Motion	EtherNet/IP
Integrated Motion on the EtherNet/IP network for time synchronization	EtherNet/IP
Control of distributed I/O	• ControlNet • DeviceNet • EtherNet/IP • Foundation Fieldbus • HART • Universal remote I/O
Produce/consume data between controllers	• ControlNet • EtherNet/IP
Messaging to and from other devices, including access to the controller via Logix Designer application	• ControlNet • DeviceNet (only to devices) • Data Highway Plus (DH+) • DH-485 • EtherNet/IP • Serial

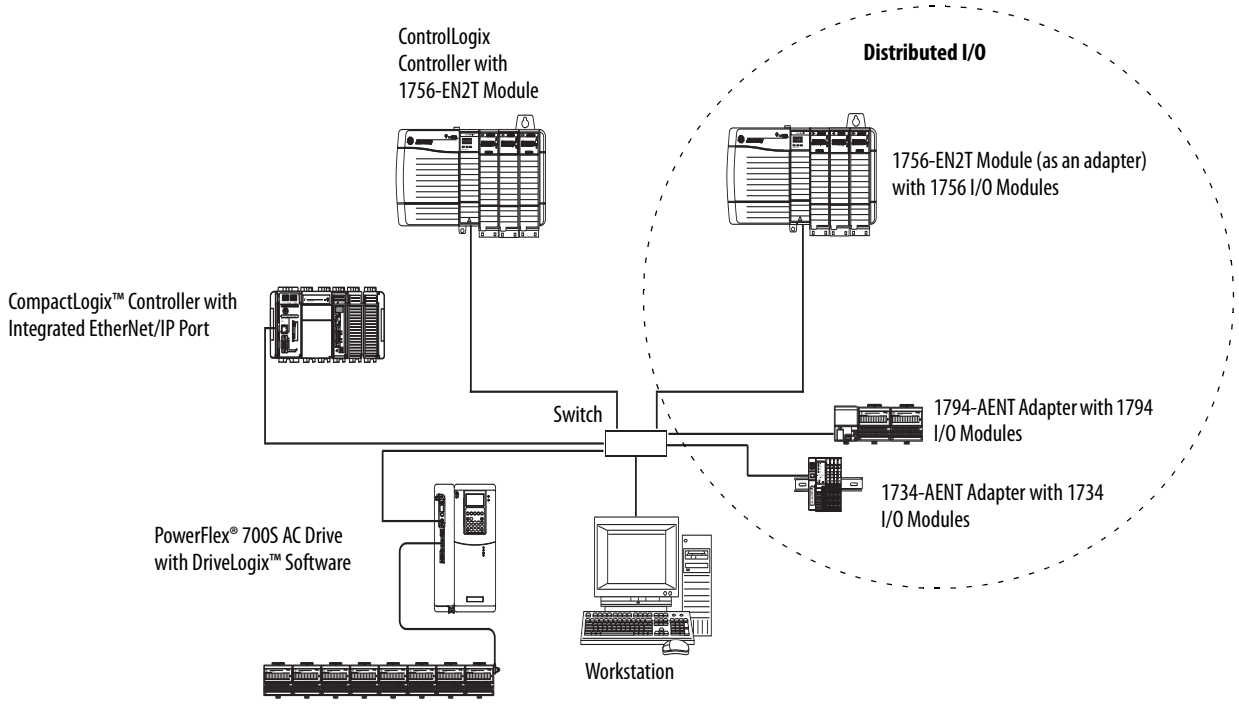
For additional information about network design for your system, see the Ethernet Design Considerations Reference Manual, publication ENET-RM002.

EtherNet/IP Network Communication

The EtherNet/IP network offers a full suite of control, configuration, and data collection services by layering the Common Industrial Protocol (CIP) over the standard Internet protocols, such as TCP/IP and UDP. This combination of well-accepted standards provides the capability required to both support information data exchange and control applications.

The EtherNet/IP network uses commercial, off-the-shelf Ethernet components and physical media, providing you with a cost-effective plant-floor solution.

Figure 10 - EtherNet/IP Network Example



For more information about using EtherNet/IP modules, see the EtherNet/IP Modules in Logix5000 Control Systems User Manual, publication ENET-UM001.

ControlLogix EtherNet/IP Module Features

The ControlLogix EtherNet/IP communication modules provide these features:

- Support for messaging, produced/consumed tags, HMI, and distributed I/O
- The ability to encapsulate messages within the standard TCP/UDP/IP protocol
- A common application layer with ControlNet and DeviceNet networks
- Network connections via an RJ45 cable
- Support half/full duplex 10 MB or 100 MB operation
- Support standard switches

ControlLogix EtherNet/IP Communication Modules

For EtherNet/IP network communication in a ControlLogix system, you have several modules to choose from. This table lists modules and their primary features.

Table 14 - EtherNet/IP Communication Modules and Capabilities

Module	Is used to
1756-ENBT	• Connect controllers to I/O modules (requires an adapter for distributed I/O). • Communicate with other EtherNet/IP devices (messages). • Serve as a pathway for data sharing between Logix5000 controllers (produce/consume). • Bridge EtherNet/IP nodes to route messages to devices on other networks.
1756-EN2T	• Perform the same functions as a 1756-ENBT module, with twice the capacity for more demanding applications. • Provide a temporary configuration connection via the USB port. • Configure IP addresses quickly by using rotary switches.
1756-EN2F	• Perform the same functions as a 1756-EN2T module. • Connect fiber media by an LC fiber connector on the module.
1756-EN2TR	• Perform the same functions as a 1756-EN2T module. • Support communication on a ring topology for a Device Level Ring (DLR) single-fault tolerant ring network.
1756-EN3TR	• Perform the same functions as the 1756-EN2TR module. • Extended Integrated Motion on EtherNet/IP network. • Support of up to 128 motion axes.
1756-EN2TXT	• Perform the same functions as a 1756-EN2T module. • Operate in extreme environments with -25…70 °C (-13…158 °F) temperatures.
1756-EWEB	• Provide customizable web pages for external access to controller information. • Provide remote access via an Internet browser to tags in a local ControlLogix controller. • Communicate with other EtherNet/IP devices (messages). • Bridge EtherNet/IP nodes to route messages to devices on other networks. • Support Ethernet devices that are not EtherNet/IP-based with a socket interface. This module does not provide support for I/O or produced/consumed tags.

Software for EtherNet/IP Networks

This table lists software that is used with the EtherNet/IP networks and modules.

Table 15 - Software for Use with EtherNet/IP Networks

Software	Is used to	Required or Optional
Logix Designer application	• Configure ControlLogix projects. • Define EtherNet/IP communication.	Required
RSLinx Classic or RSLinx® Enterprise	• Configure communication devices. • Provide diagnostics. • Establish communication between devices.	Required
BOOTP/DHCP Utility	Assign IP addresses to devices on an EtherNet/IP network.	Optional
RSNetWorx™ for EtherNet/IP	• Configure EtherNet/IP devices by IP addresses and/or host names. • Provide bandwidth status.	

Connections over an EtherNet/IP Network

You indirectly determine the number of connections the controller uses by configuring the controller to communicate with other devices in the system. Connections are allocations of resources that provide more reliable communication between devices compared to unconnected messages.

All EtherNet/IP connections are unscheduled. An unscheduled connection is triggered by the requested packet interval (RPI) for I/O control or the program, such as a MSG instruction. Unscheduled messaging lets you send and receive data when needed.

Double Data Rate (DDR) Backplane Communication

DDR communication can be achieved with the 1756-L7*x* controller. The following communication modules support DDR when used in conjunction with the 1756-L7*x* controller. Minimum series are indicated:

- 1756-EN2T/C
- 1756-EN2TR/B
- 1756-EN2TF/B
- 1756-EN2TXT/C
- 1756-EN3TR/A
- 1756-RM/B

DDR communication is achieved most efficiently when all modules in the communication path are DDR modules, or, in other words, as a single conversation (connection) only between DDR modules.

DDR communication is achievable in a chassis with a mix of DDR and non-DDR modules. The DDR communication occurs between the modules that support it. If non-DDR modules are also in the chassis, communication between those modules will be at the non-DDR rate.

For example, you could have a chassis with two 1756-L7*x* controllers in slots 0 and 1 communicating with each other using DDR, and two 1756-L6*x* controllers in slots 2 and 3 communicating using non-DDR.

When multicast communication is used within a chassis to multiple modules, the transmission rate is limited to the slowest module—or at the non-DDR rate.

For example, if a 1756-L7*x* controller is producing a tag to a 1756-L7*x* controller **and** a 1756-L6*x* controller on the same multicast connection, it must use the non-DDR rate.

ControlNet Network Communication

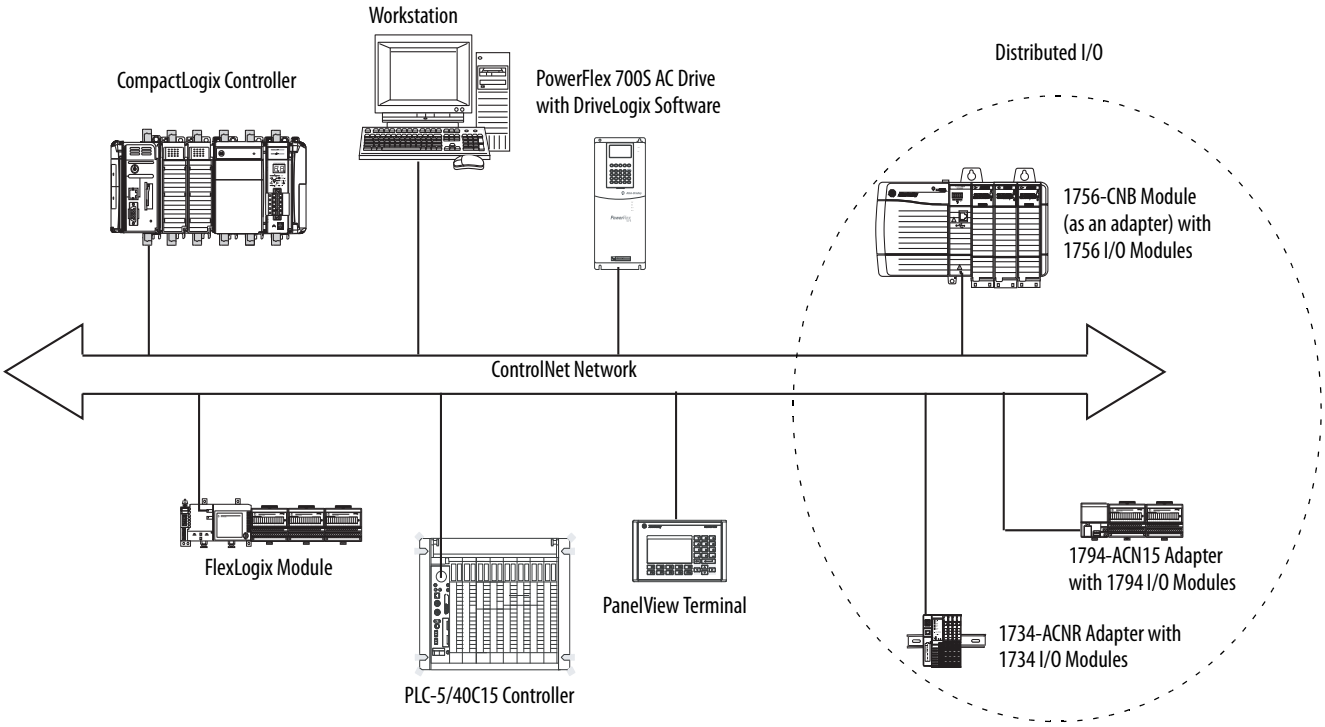
The ControlNet network is a real-time control network that provides high-speed transport of both time-critical I/O and interlocking data and messaging data. This includes uploading and downloading of program and configuration data on a single physical-media link. The ControlNet network's highly-efficient data transfer capability significantly enhances I/O performance and peer-to-peer communication in any system or application.

The ControlNet network is highly deterministic and repeatable and is unaffected when devices are connected or disconnected from the network. This quality results in dependable, synchronized, and coordinated real-time performance.

The ControlNet network often functions as the following:

- A substitute/replacement for the remote I/O (RIO) network because the ControlNet network adeptly handles large numbers of I/O points
- A backbone for multiple distributed DeviceNet networks
- A peer interlocking network

Figure 11 - ControlNet Network Overview



In this example, these actions occur via the ControlNet network:

- The controllers produce and consume tags.
- The controllers initiate MSG instructions that do the following:
  - Send and receive data.
  - Configure devices.
- The workstation is used to do the following:
  - Configure both the ControlNet devices and the ControlNet network.
  - Download and upload projects from the controllers.

For more information about using ControlNet modules, see ControlNet Modules in Logix5000 Control Systems User Manual, publication CNET-UM001.

ControlLogix ControlNet Module Features

The ControlNet communication modules provide these features:

- Support for messaging, produced/consumed tags, and distributed I/O
- Use a common application layer with DeviceNet and EtherNet/IP networks
- Requires no routing tables
- Support the use of coax and fiber repeaters for isolation and increased distance
- Support redundant media (1756-CNBR, 1756-CN2R, and 1756-CN2RXT modules only)

ControlLogix ControlNet Modules

This table lists the available ControlLogix ControlNet modules and their primary features.

Table 16 - ControlNet Modules and Capabilities

Module	Is used to
1756-CNB	• Control I/O modules. • Communicate with other ControlNet devices (messages). • Share data with other Logix5000 controllers (produce/consume). • Bridge ControlNet links to route messages to devices on other networks.
1756-CNBR	• Perform the same functions as a 1756-CNB module. • Support redundant ControlNet media.
1756-CN2	• Perform the same functions as a 1756-CNB module. • Provide twice the capacity for more demanding applications.
1756-CN2R	• Perform the same functions as a 1756-CN2 module. • Support redundant ControlNet media.
1756-CN2RXT	• Perform same functions as a 1756-CN2R module. • Operate in extreme environments with -25…70 °C (-13…158 °F) temperatures.

Software for ControlNet Networks

This table lists software that is used with the ControlNet networks and modules.

Table 17 - Software for Use with ControlNet Networks

Software	Is used to	Required or Optional
Logix Designer application	• Configure ControlLogix projects. • Define ControlNet communication.	Required
RSNetWorx™ for ControlNet™	• Configure ControlNet devices. • Schedule a network.	
RSLinx Classic or Enterprise	• Configure communication devices. • Provide diagnostics. • Establish communication between devices.	

Connections over a ControlNet Network

You indirectly determine the number of connections the controller uses by configuring the controller to communicate with other devices in the system. Connections are allocations of resources that provide more reliable communication between devices compared to unconnected messages.

Table 18 - ControlNet Connections

Connection	Definition
Scheduled (unique to a ControlNet network)	A scheduled connection is unique to ControlNet communication. A scheduled connection lets you send and receive data repeatedly at a predetermined interval, which is the requested packet interval (RPI). For example, a connection to an I/O module is a scheduled connection because you repeatedly receive data from the module at a specified interval. Other scheduled connections include connections to the following: • Communication devices • Produced/consumed tags On a ControlNet network, you must use RSNetWorx for ControlNet software to enable all scheduled connections and establish a network update time (NUT). Scheduling a connection reserves network bandwidth specifically to handle the connection.
Unscheduled	An unscheduled connection is a message transfer between devices that is triggered by the requested packet interval (RPI) or the program, such as a MSG instruction. Unscheduled messaging lets you send and receive data when you need to: Unscheduled connections use the remainder of network bandwidth after scheduled connections are allocated.

ControlNet Module Connections

The 1756-CNB and 1756-CNBR communication modules support 64 CIP connections over a ControlNet network. However, for optimal performance, configure a maximum of 48 connections for each module.

The 1756-CN2, 1756-CN2R, and 1756-CN2RXT communication modules support 128 connections over a ControlNet network, all of which can be configured without risk of performance degradation.

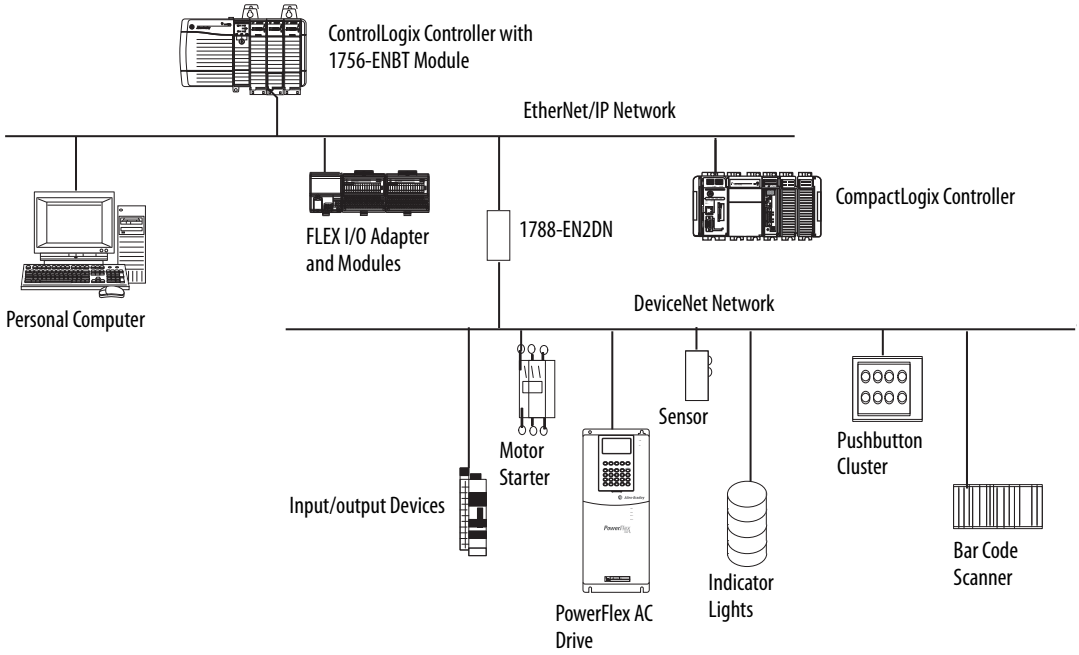
DeviceNet Network Communication

The DeviceNet network uses the Common Industrial Protocol (CIP) to provide the control, configuration, and data collection capabilities for industrial devices. The DeviceNet network uses the proven Controller Area Network (CAN) technology, which lowers installation costs and decreases installation time and costly downtime.

A DeviceNet network provides access to the intelligence present in your devices by letting you connect devices directly to plant-floor controllers without having to hard wire each device into an I/O module.

With a ControlLogix system, DeviceNet communication requires the use of a 1756-DNB DeviceNet communication module.

Figure 12 - ControlLogix DeviceNet Network Overview



In this example, the ControlLogix controller is connected to the DeviceNet network and devices via the 1788-EN2DN linking device.

For more information about using DeviceNet modules and devices, see DeviceNet Modules in Logix5000 Control Systems User Manual, publication DNET-UM004.

ControlLogix DeviceNet Module Features

The DeviceNet communication module provides these features:

- Supports messaging to devices (not controller to controller)
- Shares a common application layer with ControlNet and EtherNet/IP networks
- Offers diagnostics for improved data collection and fault detection
- Requires less wiring than standard, hard-wired systems

ControlLogix DeviceNet Bridge Module and Linking Devices

This table lists the available ControlLogix DeviceNet bridge module and linking devices that can be used with the DeviceNet network.

Table 19 - DeviceNet Communication Modules and Capabilities

Module/Device	Is used to
1756-DNB	• Control I/O modules. • Communicate with other DeviceNet devices (via messages).
1788-EN2DN	Link an EtherNet/IP network to a DeviceNet network.
1788-CN2DN	Link a ControlNet network to a DeviceNet network.

Software for DeviceNet Networks

This table lists software that is used with the DeviceNet networks and modules.

Table 20 - Software for Use with DeviceNet Networks

Software	Is used to	Required or Optional
Logix Designer application	• Configure ControlLogix projects. • Define DeviceNet communication.	Required
RSNetWorx™ for DeviceNet™	• Configure DeviceNet devices. • Define the scan list for those devices.	
RSLinx Classic or Enterprise	• Configure communication devices. • Provide diagnostics. • Establish communication between devices.	

Connections over DeviceNet Networks

The ControlLogix controller requires two connections for each 1756-DNB module. One connection is for module status and configuration. The other connection is a rack-optimized connection for the device data.

ControlLogix DeviceNet Module Memory

The 1756-DNB module has fixed sections of memory for the input and output data of the DeviceNet devices on the network. Each device on your network requires either some input or output memory of the scanner. Some devices both send and receive data, so they need both input and output memory. The 1756-DNB module supports up to add the following:

- 124 DINTs of input data
- 123 DINTs of output data

Data Highway Plus (DH+) Network Communication

For DH+ network communication, use a 1756-DHRIO module in the ControlLogix chassis to exchange information between these controllers:

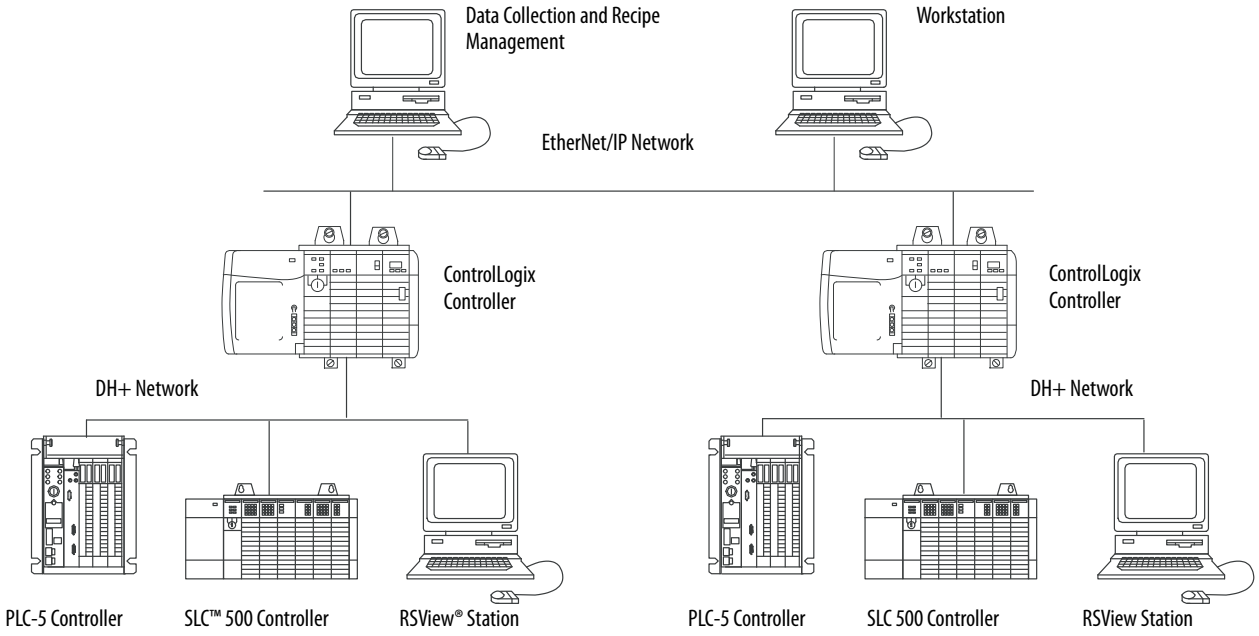
- PLC and SLC controllers
- ControlLogix controllers and PLC or SLC controllers
- ControlLogix controllers

In addition to data exchange between controllers, the DH+ network also provides the ability to regularly share data both plant-wide and at a cellular level.

You can connect a maximum of 32 stations to a single DH+ link:

- Channel A supports 57.6 Kbps, 115.2 Kbps, and 230.4 Kbps.
- Channel B supports 57.6 Kbps and 115.2 Kbps.

Figure 13 - ControlLogix DH+ Network Communication Example



Communicate over a DH+ Network

For the controller to communicate to a workstation or other device over a DH+ network, use RSLinx Classic software to do the following:

- Specify a unique link ID for each ControlLogix backplane and additional network in the communication path.
- Configure the routing table for the 1756-DHRIO module.

The 1756-DHRIO module can route a message through up to four communication networks and three chassis. This limit applies only to the routing of a message and not to the total number of networks or chassis in a system.

For more information about configuring and using a DH+ network via the 1756-DHRIO module, see the Data Highway Plus-Remote I/O Communication Interface Module User Manual, publication 1756-UM514.

Universal Remote I/O (RIO) Communication

For universal remote I/O communication, you have two module options for use in the ControlLogix chassis. This table lists the RIO modules and capabilities.

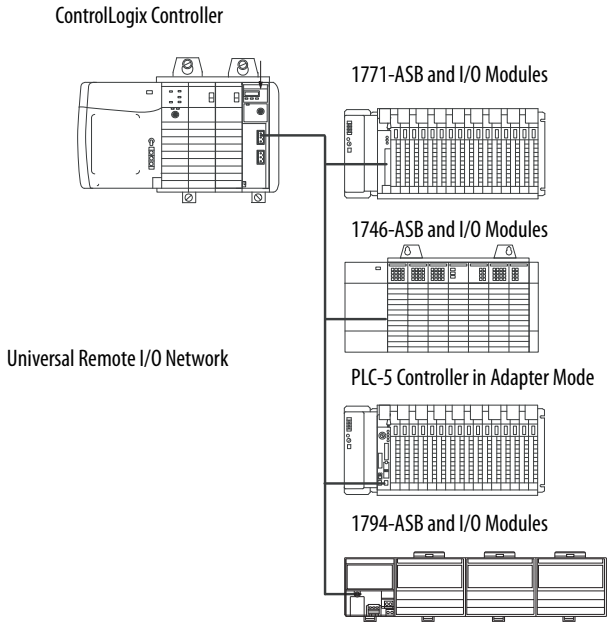
Table 21 - RIO Modules and Capabilities

RIO Module	Is used to
1756-RIO	• Function as an RIO scanner and adapter. • Support connections to 32 racks in any combination of rack size or block transfers. • Update data to the ControlLogix controller by using scheduled connections.
1756-DHRIO	• Function as an RIO scanner. • Support either 32 logical rack connections or 16 block-transfer connections per channel. • Establish connections between controllers and I/O adapters. • Distribute control so that each controller has its own I/O.

When a channel on the 1756-DHRIO module is configured for remote I/O, the module acts as a scanner for a universal remote I/O network. The controller communicates to the module to send and receive the I/O data on the universal remote I/O network.

The 1756-RIO module can act as a scanner or adapter on a remote I/O network. In addition to digital and block-transfer data, the 1756-RIO module transfers analog and specialty data without message instructions.

Figure 14 - ControlLogix Universal Remote I/O Communication Example



Communicate over a Universal Remote I/O Network

For the controller to control I/O over a universal remote I/O network, you must complete these tasks.

1. Configure the remote I/O adapter.
2. Lay out the remote I/O network cable.
3. Connect the remote I/O network cable.
4. Configure the scanner channel.

For more information about configuring a remote I/O network with the 1756-RIO or 1756-DHRIO modules, see these publications:

- Data Highway Plus-Remote I/O Communication Interface Module User Manual, publication 1756-UM514
- ControlLogix Remote I/O Communication Module User Manual, publication 1756-UM534

As you design your remote I/O network, remember the following:

- All devices connected to a remote I/O network must communicate using the same communication rate. These rates are available for remote I/O:
  - 57.6 Kbps
  - 115.2 Kbps
  - 230.4 Kbps
- You must assign unique partial and full racks to each channel used in Remote I/O Scanner mode.

  Both channels of a 1756-DHRIO module cannot scan the same partial or full rack address. Both module channels can communicate to 00...37 octal or 40...77 octal, but each channel can communicate only with one address at a time in whichever of these two ranges it falls.

Foundation Fieldbus Communication

Foundation Fieldbus is an open interoperable fieldbus designed for process control instrumentation. The fieldbus devices described in the table can be connected to the ControlLogix controller via another network as shown in the example below.

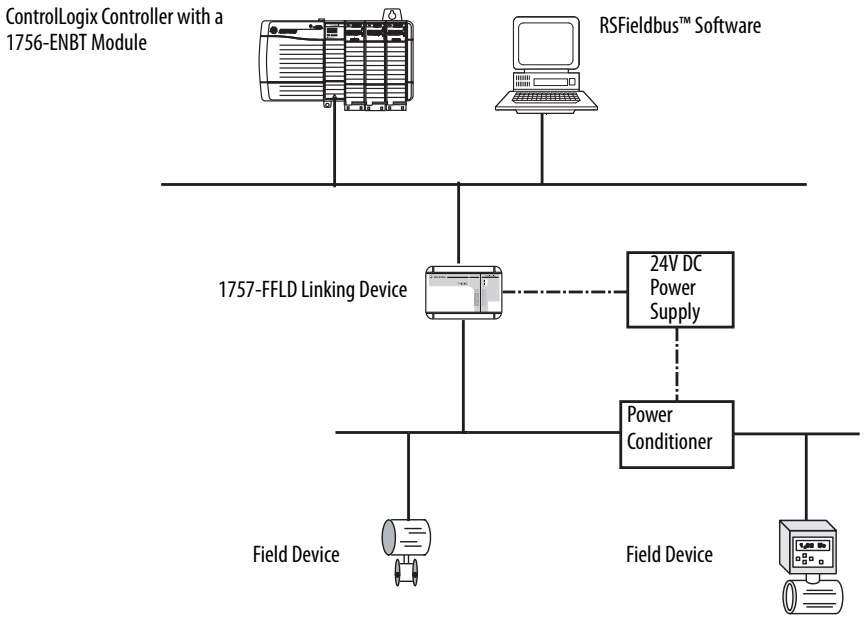
Table 22 - Fieldbus Devices and Capabilities

Fieldbus Device	Is used to
1757-FFLD	• Bridge an EtherNet/IP network to Foundation Fieldbus. • Connect via a low-speed serial (H1) and high-speed Ethernet (HSE) network connections. • Access devices directly via an OPC server.
1788-CN2FF	• Connect via low-speed serial (H1) connections. • Bridge a ControlNet network to a Foundation Fieldbus. • Support redundant ControlNet media.

Foundation Fieldbus distributes and executes control in the device. The Foundation Fieldbus linking device does the following:

- Bridges from an EtherNet/IP network to an H1 connection
- Accepts either HSE or EtherNet/IP messages and converts them to the H1 protocol

Figure 15 - Foundation Fieldbus Example



For more information about using the Foundation Fieldbus devices available from Rockwell Automation, see these publications:

- Foundation Fieldbus Linking Device User Manual, publication 1757-UM010
- ControlNet Foundation Fieldbus Linking Device User Manual, publication 1757-UM011
- RSFieldbus User Manual, publication RSBUS-UM001

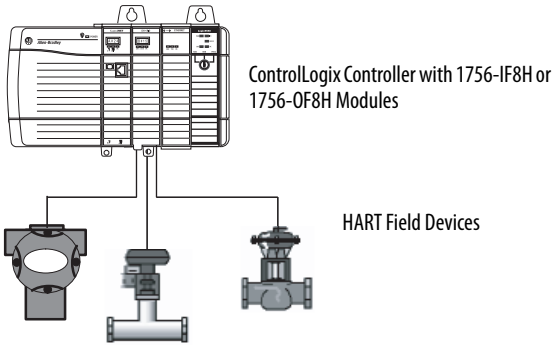
HART Communication

HART (Highway Addressable Remote Transducer) is an open protocol designed for process control instrumentation.

Device	Is used to
1756 analog I/O modules: • 1756-IF8H • 1756-OF8H	• Act as HART master to allow communication with HART field devices. • Interface directly with field devices (through built-in HART modems), eliminating need for external hardware and additional wiring. • Provide access to more field device data, including voltage and current measurements. • Directly connect asset management software to HART devices. • Support differential wiring for environments where improved noise immunity is needed (input modules).
ProSoft interface MVI56-HART	• Acquire data or control application with slow update requirements, such as a tank farm. • Does not require external hardware to access HART signal. • Does not provide a direct connection to asset management software.

The HART protocol combines digital signals with analog signals to ready the digital signal for the Process Variable (PV). The HART protocol also provides diagnostic data from the transmitter.

Figure 16 - HART Protocol Example



For more information about using the HART I/O modules, see the ControlLogix HART Analog I/O Modules User Manual, publication 1756-UM533.

For more information about the ProSoft HART interface, see the ProSoft Technologies website at http://www.prosoft-technology.com.

Manage Controller Communication

Topic	Page
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Produce and Consume (interlock) Data	114
Send and Receive Messages	116
Calculate Connection Use	117

Connection Overview

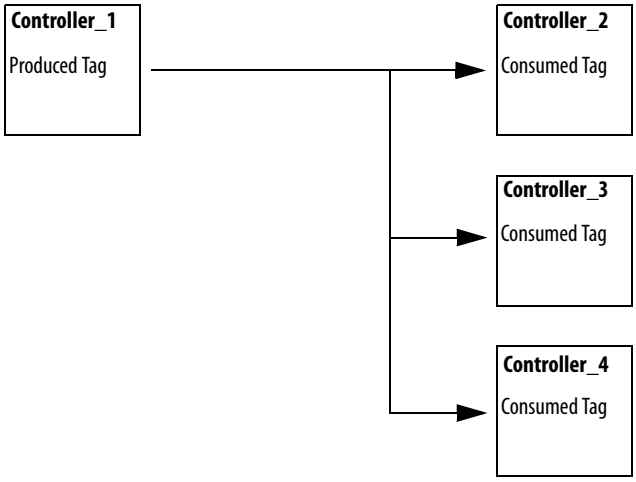
A Logix5000 system uses a connection to establish a communication link between two devices. The types of connections include the following:

- Controller-to-local I/O modules or local communication modules
- Controller-to-remote I/O or remote communication modules
- Controller-to-remote I/O (rack-optimized) modules
- Produced and consumed tags
- Messages
- Controller access via the Logix Designer application
- Controller access via RSLinx Classic or RSLinx Enterprise applications for HMI or other applications

Produce and Consume (interlock) Data

ControlLogix controllers let you produce (transmit) and consume (receive) system-shared tags.

Figure 21 - Illustration of Produced and Consumed Tags



The system-shared tags are explained in this table.

Table 26 - Produced and Consumed Tag Definitions

Tag	Definition
Produced tag	A tag that a controller makes available for use by other controllers. Multiple controllers can simultaneously consume (receive) the data. A produced tag sends its data to one or more consumed tags (consumers) without using logic.
Consumed tag	A tag that receives the data of a produced tag. The data type of the consumed tag must match the data type (including any array dimensions) of the produced tag. The RPI of the consumed tag determines the period at which the data updates.

For two controllers to share produced or consumed tags, both must be attached to the same network. You cannot bridge produced and consumed tags over two networks.

Produced and consumed tags use connections of both the controller and the communication modules being used. For a ControlNet network, produced and consumed tags use scheduled connections.

Connection Requirements of a Produced or Consumed Tag

Produced and consumed tags each require connections. As you increase the number of controllers that can consume a produced tag, you also reduce the number of connections the controller has available for other operations, like communication and I/O.

IMPORTANT If a consumed-tag connection fails, all of the other tags being consumed from that remote controller stop receiving new data.

Each produced or consumed tag uses the number of connections listed in this table. Adding status information to a produced/consumed tag does not impact the number of connections used.

Table 27 - Produced and Consumed Tag Connections

This Type of Tag	Uses This Many Connections	Of This Module
Produced tag	*number_of_configuredconsumers* + 1	Controller
Consumed tag	1	
Produced or consumed tag	1	Communication

EXAMPLE Calculations of connections for produced or consumed tags:

- A ControlLogix controller producing 4 tags for 1 controller uses 8 connections.

  Each tag uses 2 connections (1 consumer + 1 = 2).

  2 connections per tag x 4 tags = 8 connections.
- Consuming 4 tags from a controller uses 4 connections (1 connection per tag x 4 tags = 4 connections).

The number of available connections limits the number of tags that can be produced or consumed. If the controller uses all of its connections for I/O and communication devices, no connections are left for produced and consumed tags.

Table 28 - ControlLogix Modules and Available Connections

Module Type	Cat. No.	Available Connections
Controller	1756-L7*x*	500
	1756-L6*x*	250
EtherNet/IP	• 1756-EN2F • 1756-EN2T • 1756-EN2TXT • 1756-EN2TR	256
	• 1756-ENBT • 1756-EWEB	128
ControlNet	• 1756-CN2 • 1756-CN2R • 1756-CN2RXT	128
	• 1756-CNB • 1756-CNBR	64

For more information about produced/consumed tags, see the Logix5000 Controllers Produced and Consumed Tags Programming Manual, publication 1756-PM011.

Send and Receive Messages

Messages transfer data to other devices, such as other controllers or operator interfaces. The MSG instruction is a ladder logic output instruction that asynchronously reads or writes a block of data to or from another module over the backplane or a network. The size of the instruction depends on the data types and message command programmed by the user.

Messages use connection resources to send or receive data. Messages can leave the connection open (cache) or closed when the message is done transmitting.

Each message uses one connection out of the controller, regardless of how many devices are in the message path. To conserve connections, configure one message to read from or write to multiple devices.

Table 29 - Message Types

Message Type	Communication Method	Connected Message	Message Can Be Cached
CIP data table read or write	N/A	Configurable	Yes
PLC-2®, PLC-3®, PLC-5®, or SLC (all types)	CIP	No	No
	CIP with Source ID	No	No
	DH+	Yes	Yes
CIP generic	N/A	Optional (1)	Yes(2)
Block-transfer read or write	N/A	Yes	Yes

(1) You can connect CIP generic messages. However, for most applications we recommend you leave CIP generic messages unconnected.

(2) Consider caching only if the target module requires a connection.

For more information about using messages, see these publications:

- Logix5000 Controllers Messages, publication 1756-PM012
- Logix5000 Controllers General Instructions, publication 1756-RM003

Determine Whether to Cache Message Connections

When you configure a MSG instruction, you can choose whether to cache the connection. Use this table to determine if you should cache connections.

Table 30 - Options for Caching Connections

If the message executes	Then
Repeatedly	Cache the connection. This keeps the connection open and optimizes execution time. Opening a connection each time the message executes increases execution time.
Infrequently	Do not cache the connection. This closes the connection upon completion of the message, which frees up that connection for other uses.

TIP Cached connections transfer data faster than uncached connections.The controller only supports 32 cached messages.

Calculate Connection Use

The total connection requirements of a ControlLogix system include both local and remote connections.

Local Connections

Local connections refer to connections used to communicate between modules housed in the same ControlLogix chassis (that is, the local modules). Use this table to calculate the number of local connections based on the configuration of your local chassis.

Table 31 - Local Chassis Connections

Local Connection To	Device Quantity	Connections per Device	Total Connections
Local I/O module (always a direct connection)		1	
1756-M16SE, 1756-M08SE, or 1756-M02AE servo module		3	
• 1756-CN2, 1756-CN2R, 1756-CN2RXT ControlNet communication module • 1756-CNB, 1756-CNBR ControlNet communication module		0	
• 1756-EN2F, 1756-EN2T, 1756-EN2TXT, or 1756-EN2TR EtherNet/IP communication module • 1756-ENBT EtherNet/IP communication module		0	
1756-EWEB EtherNet/IP web server module		0	
1756-DNB DeviceNet communication module		2	
1756-RIO remote I/O communication module (Connection count depends on module configuration and could be as many as 10 per module.)		1	
1756-DHRIO DH+/universal remote I/O communication module Each adapter associated with the module		1 1	
1756-DH485 DH-485 communication module		1	
		Total	

Remote Connections

Use remote connections when the communication module is in a chassis that is remote from the controller. The number of connections a communication module supports determines how many remote connections the controller can access through that module.

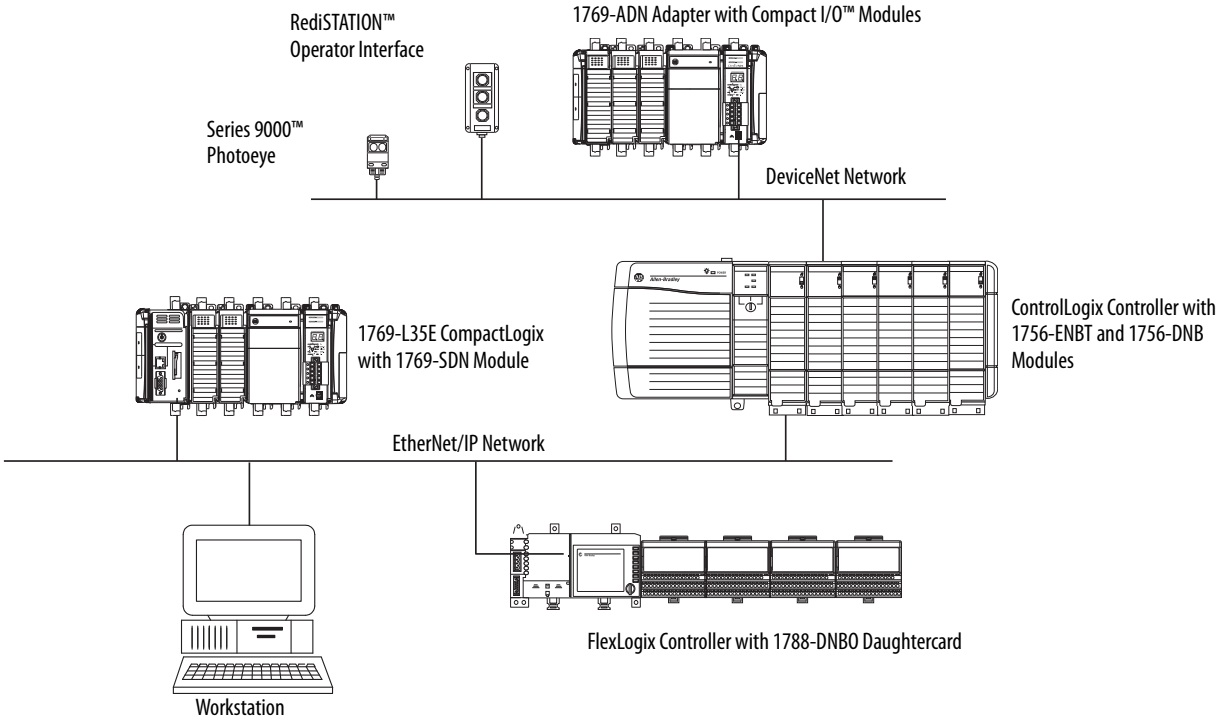
Table 32 - Remote Connections

Remote Connection Type	Device Quantity	Connections per Device	Total Connections
Remote ControlNet communication module I/O configured as direct connection (none) I/O configured as rack-optimized connection		 0 1	
Remote I/O module over a ControlNet network (direct connection)		1	
Remote EtherNet/IP communication module I/O configured as direct connection (none) I/O configured as rack-optimized connection		 0 1	
Remote I/O module over a EtherNet/IP network (direct connection)		1	
Remote device over a DeviceNet network (accounted for in rack-optimized connection for local 1756-DNB)		 0	
DeviceNet module in a remote chassis		2	
Other remote communication adapter		1	
Produced tag Each consumer		1 1	
Consumed tag		1	
Message (see Table 29 for message types) Connected Unconnected		 1 0	
Block-transfer message		1	
		Total	

Connections Example

In this example system, the 1756 ControlLogix controller does the following:

- Controls local digital I/O modules in the same chassis
- Controls remote I/O devices on a DeviceNet network
- Sends and receives messages to and from a CompactLogix controller on an EtherNet/IP network
- Produces one tag that the 1794 FlexLogix controller consumes
- Is programmed via the Logix Designer application



The ControlLogix controller in this example uses these connections.

Table 33 - Connections Example Calculation

Connection Type	Device Quantity	Connections per Device	Total Connections
Controller to local I/O modules	4	1	4
Controller to 1756-ENBT module	1	0	0
Controller to 1756-DNB module	1	2	2
Controller to Logix Designer application	1	1	1
Message to CompactLogix controller	2	1	2
Produced tag Consumed by FlexLogix controller	1 1	1 1	1 1
		Total	11

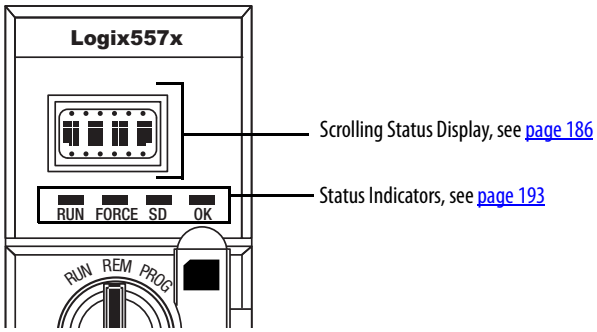
Status Indicators

Topic	Page
1756-L7x Controller Status Display and Indicators	185
1756-L7x Controller Status Display	185
1756-L7x Controller Status Indicators	193
1756-L6x Status Indicators	194

1756-L7*x* Controller Status Display and Indicators

The 1756-L7*x* controllers have four status indicators and one four-character scrolling status display.

Figure 50 - 1756-L7*x* Status Display and Indicators



1756-L7*x* Controller Status Display

The 1756-L7*x* controller status display scrolls messages that provide information about the controller's firmware revision, ESM status, project status, and major faults.

General Status Messages

The messages described in this table are typically indicated upon powerup, powerdown, and while the controller is running to show the status of the controller and the ESM.

Table 49 - General Status Messages

Message	Interpretation
No message is indicated	The controller is Off. Check the OK indicator to determine if the controller is powered and determine the state of the controller.
TEST	Power-up tests are being conducted by the controller.
PASS	Power-up tests have been successfully completed.
SAVE	A project is being saved to the SD card. You can also view the SD Indicator (see page 193) for additional status information. Allow the save to complete before: • removing the SD card. • disconnecting power.
LOAD	A project is being loaded from the SD card at controller powerup. You can also view the SD Indicator (see page 193) for additional status information. Allow the load to complete before doing the following: • Removing the SD card • Disconnecting power • Removing the ESM module
UPDT	A firmware upgrade is being conducted from the SD card upon powerup. You can also view the SD Indicator (see page 193) for additional status information. If you do not want the firmware to update upon powerup, change the controller's Load Image property.
CHRG	The capacitor-based ESM is being charged.
1756-L7*x*/*X*	The controller catalog number and series.
Rev *XX.xxx*	The major and minor revision of the controller's firmware.
No Project	No project is loaded on the controller. To load a project, do one of the following: • Use Logix Designer application to download the project to the controller • Use a SD card to load a project to the controller
Project Name	The name of the project that is currently loaded on the controller.
BUSY	The I/O modules associated with the controller are not yet fully-powered. Allow time for powerup and I/O module self-testing.
Corrupt Certificate Received	The security certificate associated with the firmware is corrupted. Go to http://www.rockwellautomation.com/support/ and download the firmware revision you are trying to upgrade to. Replace the firmware revision you have previously installed with that posted on the Technical Support website.
Corrupt Image Received	The firmware file is corrupted. Go to http://www.rockwellautomation.com/support/ and download the firmware revision you are trying to upgrade to. Replace the firmware revision you have previously installed with that posted on the Technical Support website.
ESM Not Present	An ESM is not present and the controller cannot save the application at powerdown. Insert a compatible ESM, and, if using a capacitor-based ESM, do not remove power until the ESM is charged.
ESM Incompatible	The ESM is incompatible with the memory size of the controller. Replace the incompatible ESM with a compatible ESM.
ESM Hardware Failure	A failure with the ESM has occurred and the controller is incapable of saving of the program in the event of a powerdown. Replace the ESM before removing power to the controller so the controller program is saved.
ESM Energy Low	The capacitor-based ESM does not have sufficient energy to enable the controller to save the program in the event of a powerdown. Replace the ESM.
ESM Charging	The capacitor-based ESM is charging. Do not remove power until charging is complete.

Table 49 - General Status Messages (continued)

Message	Interpretation
Flash in Progress	A firmware upgrade initiated via ControlFLASH or AutoFlash utilities is in progress. Allow the firmware upgrade to complete without interruption.
Firmware Installation Required	The controller is using boot firmware (that is revision 1.*xxx*) and requires a firmware upgrade. Upgrade controller firmware.
SD Card Locked	An SD card that is locked is installed.

Fault Messages

If the controller is faulted, these messages may be indicated on the status display.

Table 50 - Fault Messages

Message	Interpretation
Major Fault T*XX*:C*XX message*	A major fault of Type *XX* and Code *XX* has been detected. For example, if the status display indicates Major Fault T04:C42 Invalid JMP Target, then a JMP instruction is programmed to jump to an invalid LBL instruction. For details about major recoverable faults, see the Logix5000 Major, Minor, and I/O Fault Codes Programming Manual, publication 1756-PM014.
I/O Fault Local:*X #XXXX message*	An I/O fault has occurred on a module in the local chassis. The slot number and fault code are indicated along with a brief description. For example, I/O Fault Local:3 #0107 Connection Not Found indicates that a connection to the local I/O module in slot three is not open. Take corrective action specific to the type of fault indicated. For details about each I/O fault code, see the Logix5000 Major, Minor, and I/O Fault Codes Programming Manual, publication 1756-PM014.
I/O Fault *ModuleName #XXXX message*	An I/O fault has occurred on a module in a remote chassis. The name of the faulted module is indicated with the fault code and brief description of the fault. For example, I/O Fault My_Module #0107 Connection Not Found indicates that a connection to the module named My_Module is not open. Take corrective action specific to the type of fault indicated. For details about each I/O fault code, see the Logix5000 Major, Minor, and I/O Fault Codes Programming Manual, publication 1756-PM014.
I/O Fault *ModuleParent:X #XXXX message*	An I/O fault has occurred on a module in a remote chassis. The module's parent name is indicated because no module name is configured in the I/O Configuration tree of Logix Designer application. In addition, the fault code is indicated with a brief description of the fault. For example, I/O Fault My_CNet:3 #0107 Connection Not Found indicates that a connection to a module in slot 3 of the chassis with the communication module named My_CNet is not open. Take corrective action specific to the type of fault indicated. For details about each I/O fault code, see the Logix5000 Major, Minor, and I/O Fault Codes Programming Manual, publication 1756-PM014.
X I/O Faults	I/O faults are present and *X* = the number of I/O faults present. In the event of multiple I/O faults, the controller indicates the first fault reported. As each I/O fault is resolved, the number of faults indicated decreases and the next fault reported is indicated by the I/O Fault message. Take corrective action specific to the type of fault indicated. For details about each I/O fault code, see the Logix5000 Major, Minor, and I/O Fault Codes Programming Manual, publication 1756-PM014.

Major Fault Messages

Major faults are indicated by Major Fault T*XX*:C*XX message* on the controller status display. This table lists specific fault types, codes, and the associated messages as they are shown on the status display.

For detailed descriptions and suggested recovery methods for major faults, see the Logix5000 Major, Minor, and I/O Fault Codes Programming Manual, publication 1756-PM014.

Table 51 - Major Fault Status Messages

Type	Code	Message
1	1	Run Mode Powerup
1	60	Non-recoverable
1	61	Non-recoverable – Diagnostics Saved on CF Card
1	62	Non-recoverable – Diagnostics and Program Saved on SD Card
3	16	I/O Connection Failure
3	20	Chassis Failure
3	21	
3	23	Connection Failure
4	16	Unknown Instruction
4	20	Invalid Array Subscript
4	21	Control Structure LEN or POS < 0
4	31	Invalid JSR Parameter
4	34	Timer Failure
4	42	Invalid JMP Target
4	82	SFC Jump Back Failure
4	83	Value Out of Range
4	84	Stack Overflow
4	89	Invalid Target Step
4	90	Invalid Instruction
4	91	Invalid Context
4	92	Invalid Action
4	990	User-defined
4	991	
4	992	
4	993	
4	994	
4	995	
4	996	
4	997	
4	998	
4	999	

Table 51 - Major Fault Status Messages (continued)

Type	Code	Message
6	1	Task Watchdog Expired
7	40	Save Failure
7	41	Bad Restore Type
7	42	Bad Restore Revision
7	43	Bad Restore Checksum
8	1	Keyswitch Change Ignored
11	1	Positive Overtravel Limit Exceeded
11	2	Negative Overtravel Limit Exceeded
11	3	Position Error Tolerance Exceeded
11	4	Encoder Channel Connection Fault
11	5	Encoder Noise Event Detected
11	6	SERCOS Drive Fault
11	7	Synchronous Connection Fault
11	8	Servo Module Fault
11	9	Asynchronous Connection Fault
11	10	Motor Fault
11	11	Motor Thermal Fault
11	12	Drive Thermal Fault
11	13	SERCOS Communications Fault
11	14	Inactive Drive Enable Input Detected
11	15	Drive Phase Loss Detected
11	16	Drive Guard Fault
11	32	Motion Task Overlap Fault
11	33	CST Reference Loss Detected
18	1	CIP Motion Initialization Fault
18	2	CIP Motion Initialization Fault Mfg
18	3	CIP Motion Axis Fault
18	4	CIP Motion Axis Fault Mfg
18	5	CIP Motion Fault
18	6	CIP Module Fault
18	7	Motion Group Fault
18	8	CIP Motion Configuration Fault
18	9	CIP Motion APR Fault
18	10	CIP Motion APR Fault Mfg
18	128	CIP Motion Guard Fault

I/O Fault Codes

I/O faults indicated by the controller are indicated on the status display in one of these formats:

- I/O Fault Local:*X #XXXX message*
- I/O Fault *ModuleName #XXXX message*
- I/O Fault *ModuleParent*:*X #XXXX message*

The first part of the format is used to indicate the location of the faulted module. How the location is indicated depends on your I/O configuration and the module's properties specified in Logix Designer application.

The latter part of the format, #XXXX message, can be used to diagnose the type of I/O fault and potential corrective actions. For details about each I/O fault code, see the Logix5000 Major, Minor, and I/O Fault Codes Programming Manual, publication 1756-PM014.

Table 52 - I/O Fault Messages

Code	Message
#0001	Connection Failure
#0002	Insufficient Resource
#0003	Invalid Value
#0004	IOI Syntax
#0005	Destination Unknown
#0006	Partial Data Transferred
#0007	Connection Lost
#0008	Service Unsupported
#0009	Invalid Attribute Value
#000A	Attribute List Error
#000B	State Already Exists
#000C	Object Mode Conflict
#000D	Object Already Exists
#000E	Attribute Not Settable
#000F	Permission Denied
#0010	Device State Conflict
#0011	Reply Too Large
#0012	Fragment Primitive
#0013	Insufficient Command Data
#0014	Attribute Not Supported
#0015	Data Too Large
#0100	Connection In Use
#0103	Transport Not Supported
#0106	Ownership Conflict
#0107	Connection Not Found

Table 52 - I/O Fault Messages (continued)

Code	Message
#0108	Invalid Connection Type
#0109	Invalid Connection Size
#0110	Module Not Configured
#0111	RPI Out of Range
#0113	Out of Connections
#0114	Wrong Module
#0115	Wrong Device Type
#0116	Wrong Revision
#0117	Invalid Connection Point
#0118	Invalid Configuration Format
#0119	Module Not Owned
#011A	Out of Connection Resources
#0203	Connection Timeout
#0204	Unconnected Message Timeout
#0205	Invalid Parameter
#0206	Message Too Large
#0301	No Buffer Memory
#0302	Bandwidth Not Available
#0303	No Bridge Available
#0304	ControlNet Schedule Error
#0305	Signature Mismatch
#0306	CCM Not Available
#0311	Invalid Port
#0312	Invalid Link Address
#0315	Invalid Segment Type
#0317	Connection Not Scheduled
#0318	Invalid Link Address
#0319	No Secondary Resources Available
#031E	No Available Resources
#031F	No Available Resources
#0800	Network Link Offline
#0801	Incompatible Multicast RPI
#0814	Data Type Mismatch
#FD01	Bad Backplane EEPROM
#FD02	No Error Code
#FD03	Missing Required Connection
#FD04	No CST Master
#FD05	Axis or GRP Not Assigned
#FD06	SERCOS Transition Fault

Table 52 - I/O Fault Messages (continued)

Code	Message
#FD07	SERCOS Init Ring Fault
#FD08	SERCOS Comm Fault
#FD09	SERCOS Init Node Fault
#FD0A	Axis Attribute Reject
#FD1F	Safety I/O
#FD20	No Safety Task
#FE01	Invalid Connection Type
#FE02	Invalid Update Rate
#FE03	Invalid Input Connection
#FE04	Invalid Input Data Pointer
#FE05	Invalid Input Data Size
#FE06	Invalid Input Force Pointer
#FE07	Invalid Output Connection
#FE08	Invalid Output Data Pointer
#FE09	Invalid Output Data Size
#FE0A	Invalid Output Force Pointer
#FE0B	Invalid Symbol String
#FE0C	Invalid Scheduled P/C Instance
#FE0D	Invalid Symbol Instance
#FE0E	Module Firmware Updating
#FE0F	Invalid Firmware File Revision
#FE10	Firmware File Not Found
#FE11	Firmware File Invalid
#FE12	Automatic Firmware Update Failed
#FE13	Update Failed - Active Connection
#FE14	Searching Firmware File
#FE22	Invalid Connection Type
#FE23	Invalid Unicast Allowed
#FF00	No Connection Instance
#FF01	Path Too Long
#FF04	Invalid State
#FF08	Invalid Path
#FF0B	Invalid Config
#FF0E	No Connection Allowed

1756-L7*x* Controller Status Indicators

The status indicators are below the status display on the controller. They indicate the state of the controller as described in these tables.

RUN Indicator

To change the controller mode indicated by the RUN indicator, either use the mode switch on the front of the controller or use the Controller Status menu in the Logix Designer application.

Table 53 - RUN Indicator

State	Description
Off	The controller is either in Program or Test mode.
Steady green	The controller is in Run mode.

FORCE Indicator

The Force indicator shows if I/O forces are enabled on the controller.

Table 54 - FORCE Indicator

State	Description
Off	No tags contain I/O force values.
Solid amber	I/O forces are active (enabled) though I/O force values may or may not be configured. **Use caution if you install (add) a force. If you install (add) a force, it immediately takes effect.**
Flashing amber	One or more input or output addresses have been forced to an On or Off state, but the forces have not been enabled. **Use caution if you enable I/O forces. If you enable I/O forces, all existing I/O forces also take effect.**

SD Indicator

The SD indicator shows if the Secure Digital (SD) card is in use.

Table 55 - SD Indicator

State	Description
Off	No activity is occurring with the SD card.
Flashing green	The controller is reading from or writing to the SD card. Do not remove the SD card while the controller is reading or writing.
Solid green	
Flashing red	The SD card does not have a valid file system.
Solid red	The SD card is not recognized by the controller.

OK Indicator

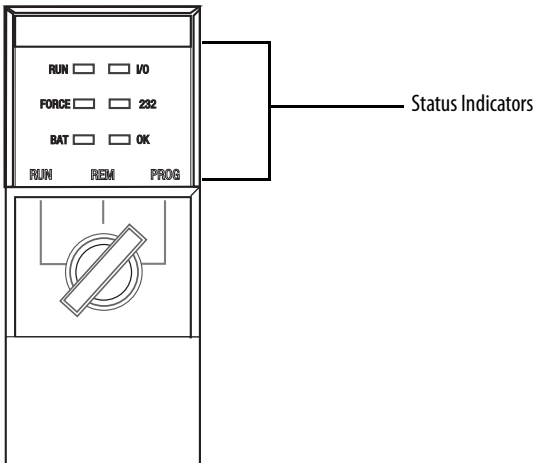
The OK indicator shows the state of the controller.

Table 56 - OK Indicator

State	Description
Off	No power is applied to the controller.
Flashing red	Either of the following is true: • It is a new controller, just out of the box, and it requires a firmware upgrade. If a firmware upgrade is required, the status display indicates Firmware Installation Required. To upgrade firmware, see Upgrade Controller Firmware on page 50. • It is a previously-used or in-use controller and a major fault has occurred. For details about major recoverable and nonrecoverable faults, see the Logix5000 Major, Minor, and I/O Fault Codes Programming Manual, publication 1756-PM014.
Solid red	One of the following is true: • The controller is completing power-up diagnostics • The charge of the capacitor in the ESM is being discharged upon powerdown. • The controller is powered, but is inoperable. • The controller is loading a project to nonvolatile memory.
Solid green	The controller is operating normally.

1756-L6*x* Status Indicators

The 1756-L6*x* controllers have status indicators on the front of the controller at show the state of the controller.



RUN Indicator

To change the controller mode indicated by the RUN indicator, either use the mode switch on the front of the controller or use the Controller Status menu in the Logix Designer application.

Table 57 - RUN Indicator

State	Description
Off	The controller is either in Program or Test mode.
Steady green	The controller is in Run mode.

I/O Indicator

The I/O indicator shows the status of I/O modules in the controller's project.

Table 58 - I/O Indicator

State	Description
Off	Either of the following is true: • There are no devices are in the I/O configuration of the controller. If needed, add the required devices to the I/O configuration of the controller. • The controller does not contain a project (controller memory is empty). If prepared, download the project to the controller.
Solid green	The controller is communicating with all of the devices in its I/O configuration.
Flashing green	One or more devices in the I/O configuration of the controller are not responding. For more information, go online with the Logix Designer application to check the I/O configuration of the controller.
Flashing red	A chassis fault exists. Troubleshoot the chassis and replace it if necessary.

FORCE Indicator

The FORCE indicator shows if I/O forces are active or enabled.

Table 59 - FORCE Indicator

State	Description
Off	Either of the following is true: • No tags contain I/O force values. • I/O forces are inactive (disabled).
Steady amber	I/O forces are active (enabled) though I/O force values may or may not be configured. **Use caution if you install (add) a force. If you install (add) a force, it immediately takes effect.**
Flashing amber	One or more input or output addresses have been forced to an On or Off state, but the forces have not been enabled. **Use caution if you enable I/O forces. If you enable I/O forces, all existing I/O forces also take effect.**

RS232 Indicator

The RS232 indicator shows if the serial port is in use.

Table 60 - RS232 Status Indicator

State	Description
Off	There is no serial connection activity.
Flashing green	There is serial connection activity.

BAT Indicator

The BAT indicator shows the charge of the battery and if the program is being saved.

Table 61 - BAT Indicator

State	Controller Series	Description
Off	N/A	The controller is able to support memory.
Solid green	A	The series A controllers do not use this state.
	B	The series B controller is conducting a save of the program to internal-nonvolatile memory during a controller power down.
Solid red	N/A	Either of the following is true: • A battery is not installed. • The battery is 95% discharged and should be replaced. Note that if the indicator is solid red before a power down, the indicator remains red while the controller is completing a program save to internal-nonvolatile memory.

OK Indicator

The OK indicator shows the state of the controller.

Table 62 - OK Indicator

State	Description
Off	No power is applied to the controller.
Flashing red	Either of the following is true: • It is a new controller, just out of the box, and it requires a firmware upgrade. • It is a previously-used or in-use controller and a major fault has occurred. • The controller is experiencing a non-recoverable, major fault.
Steady red	• A nonrecoverable major fault occurred and the program was cleared from memory. • The controller is completely powered up, in diagnostics mode. • The controller is powered, but inoperable.
Steady green	The controller is operating normally.
Flashing green	The controller is storing or loading a project to or from nonvolatile memory. If using a CompactFlash card, leave the card in the controller until the OK status indicator turns solid green.

Using Electronic Keying

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Electronic Keying

The electronic keying feature automatically compares the expected module, as shown in the RSLogix 5000 I/O Configuration tree, to the physical module before I/O communication begins. You can use electronic keying to help prevent communication to a module that does not match the type and revision expected.

For each module in the I/O Configuration tree, the user-selected keying option determines if, and how, an electronic keying check is performed. Typically, three keying option are available:

- Exact Match
- Compatible Keying
- Disable Keying

You must carefully consider the benefits and implications of each keying option when selecting between them. For some specific module types, fewer options are available.

Electronic keying is based on a set of attributes unique to each product revision. When a Logix5000 controller begins communicating with a module, this set of keying attributes is considered.

Table 63 - Keying Attributes

Attribute	Description
Vendor	The manufacturer of the module, for example, Rockwell Automation/Allen-Bradley.
Product Type	The general type of the module, for example, communication adapter, AC drive, or digital I/O.
Product Code	The specific type of module, generally represented by its catalog number, for example, 1756-IB16I.
Major Revision	A number that represents the functional capabilities and data exchange formats of the module. Typically, although not always, a later, that is higher, Major Revision supports at least all of the data formats supported by an earlier, that is lower, Major Revision of the same catalog number and, possibly, additional ones.
Minor Revision	A number that indicates the module's specific firmware revision. Minor Revisions typically do not impact data compatibility but may indicate performance or behavior improvement.

You can find revision information on the General tab of a module's Properties dialog box.

Figure 51 - General Tab

IMPORTANT	Changing electronic keying selections online may cause the I/O communication connection to the module to be disrupted and may result in a loss of data.

Exact Match

Exact Match keying requires all keying attributes, that is, Vendor, Product Type, Product Code (catalog number), Major Revision, and Minor Revision, of the physical module and the module created in the software to match precisely to establish communication. If any attribute does not match precisely, I/O communication is not permitted with the module or with modules connected through it, as in the case of a communication module.

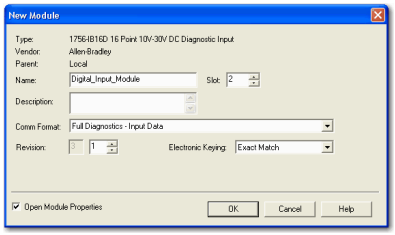
Use Exact Match keying when you need the system to verify that the module revisions in use are exactly as specified in the project, such as for use in highly-regulated industries. Exact Match keying is also necessary to enable Automatic

Firmware Update for the module via the Firmware Supervisor feature from a Logix5000 controller.

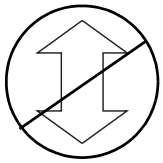
EXAMPLE In the following scenario, Exact Match keying prevents I/O communication.

The module configuration is for a 1756-IB16D module with module revision 3.1. The physical module is a 1756-IB16D module with module revision 3.2. In this case, communication is prevented because the Minor Revision of the module does not match precisely.

Module Configuration
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16D
Major Revision = 3
Minor Revision = 1

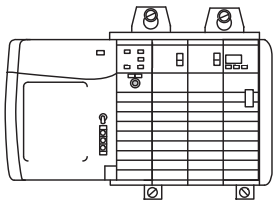


Communication is prevented.



Physical Module

Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16D
Major Revision = 3
Minor Revision = 2



IMPORTANT Changing electronic keying selections online may cause the I/O Communication connection to the module to be disrupted and may result in a loss of data.

Compatible Keying

Compatible Keying indicates that the module determines whether to accept or reject communication. Different module families, communication adapters, and module types implement the compatibility check differently based on the family capabilities and on prior knowledge of compatible products.

Compatible Keying is the default setting. Compatible Keying allows the physical module to accept the key of the module configured in the software, provided that the configured module is one the physical module is capable of emulating. The exact level of emulation required is product and revision specific.

With Compatible Keying, you can replace a module of a certain Major Revision with one of the same catalog number and the same or later, that is higher, Major Revision. In some cases, the selection makes it possible to use a replacement that is a different catalog number than the original. For example, you can replace a

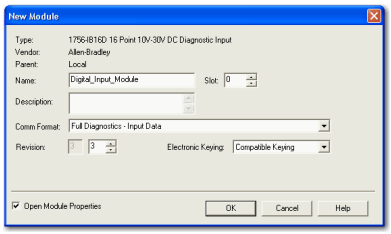
1756-CNBR module with a 1756-CN2R module. The release notes for individual modules indicate the specific compatibility details.

When a module is created, the module developers consider the module's development history to implement capabilities that emulate those of the previous module. However, the developers cannot know future developments. Because of this, when a system is configured, we recommend that you configure your module using the earliest, that is, lowest, revision of the physical module that you believe will be used in the system. By doing this, you can avoid the case of a physical module rejecting the keying request because it is an earlier revision than the one configured in the software.

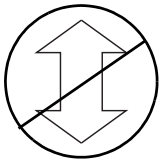
EXAMPLE In the following scenario, **Compatible Keying prevents I/O communication**.

The module configuration is for a 1756-IB16D module with module revision 3.3. The physical module is a 1756-IB16D module with module revision 3.2. In this case, communication is prevented because the minor revision of the module is lower than expected and may not be compatible with 3.3.

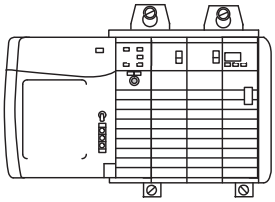
Module Configuration
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16D
Major Revision = 3
Minor Revision = 3



Communication is prevented.

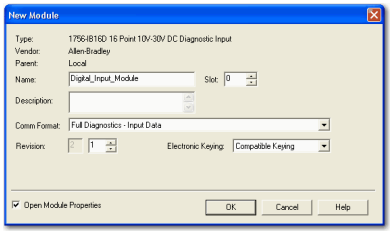


Physical Module
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16D
Major Revision = 3
Minor Revision = 2

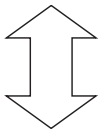


EXAMPLE In the following scenario, **Compatible Keying allows I/O communication**: The module configuration is for a 1756-IB16D module with module revision 2.1. The physical module is a 1756-IB16D module with module revision 3.2. In this case, communication is allowed because the major revision of the physical module is higher than expected and the module determines that it is compatible with the prior major revision.

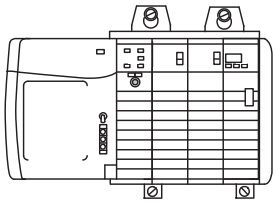
Module Configuration
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16D
Major Revision = 2
Minor Revision = 1



Communication is allowed.



Physical Module
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16D
Major Revision = 3
Minor Revision = 2



IMPORTANT Changing electronic keying selections online may cause the I/O communication connection to the module to be disrupted and may result in a loss of data.

Disabled Keying

Disabled Keying indicates the keying attributes are not considered when attempting to communicate with a module. Other attributes, such as data size and format, are considered and must be acceptable before I/O communication is established. With Disabled Keying, I/O communication may occur with a module other than the type specified in the I/O Configuration tree with unpredictable results. We generally do not recommend using Disabled Keying.

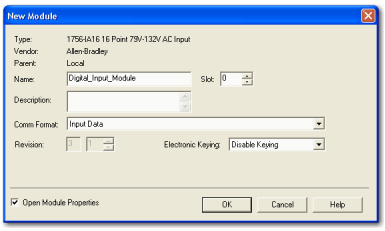
ATTENTION: Be extremely cautious when using Disabled Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss.

If you use Disabled Keying, you must take full responsibility for understanding whether the module being used can fulfill the functional requirements of the application.

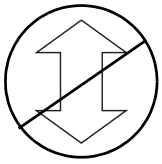
EXAMPLE In the following scenario, **Disable Keying prevents I/O communication**.

The module configuration is for a 1756-IA16 digital input module. The physical module is a 1756-IF16 analog input module. In this case, **communication is prevented because the analog module rejects the data formats that the digital module configuration requests**.

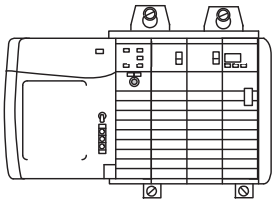
Module Configuration
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IA16
Major Revision = 3
Minor Revision = 1



Communication is prevented.



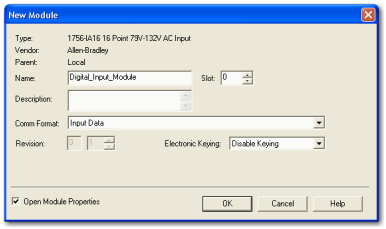
Physical Module
Vendor = Allen-Bradley
Product Type = Analog Input Module
Catalog Number = 1756-IF16
Major Revision = 3
Minor Revision = 2



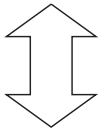
EXAMPLE In the following scenario, **Disable Keying allows I/O communication**.

The module configuration is for a 1756-IA16 digital input module. The physical module is a 1756-IB16 digital input module. In this case, communication is allowed because the two digital modules share common data formats.

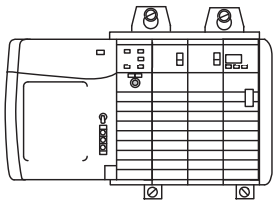
Module Configuration
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IA16
Major Revision = 2
Minor Revision = 1



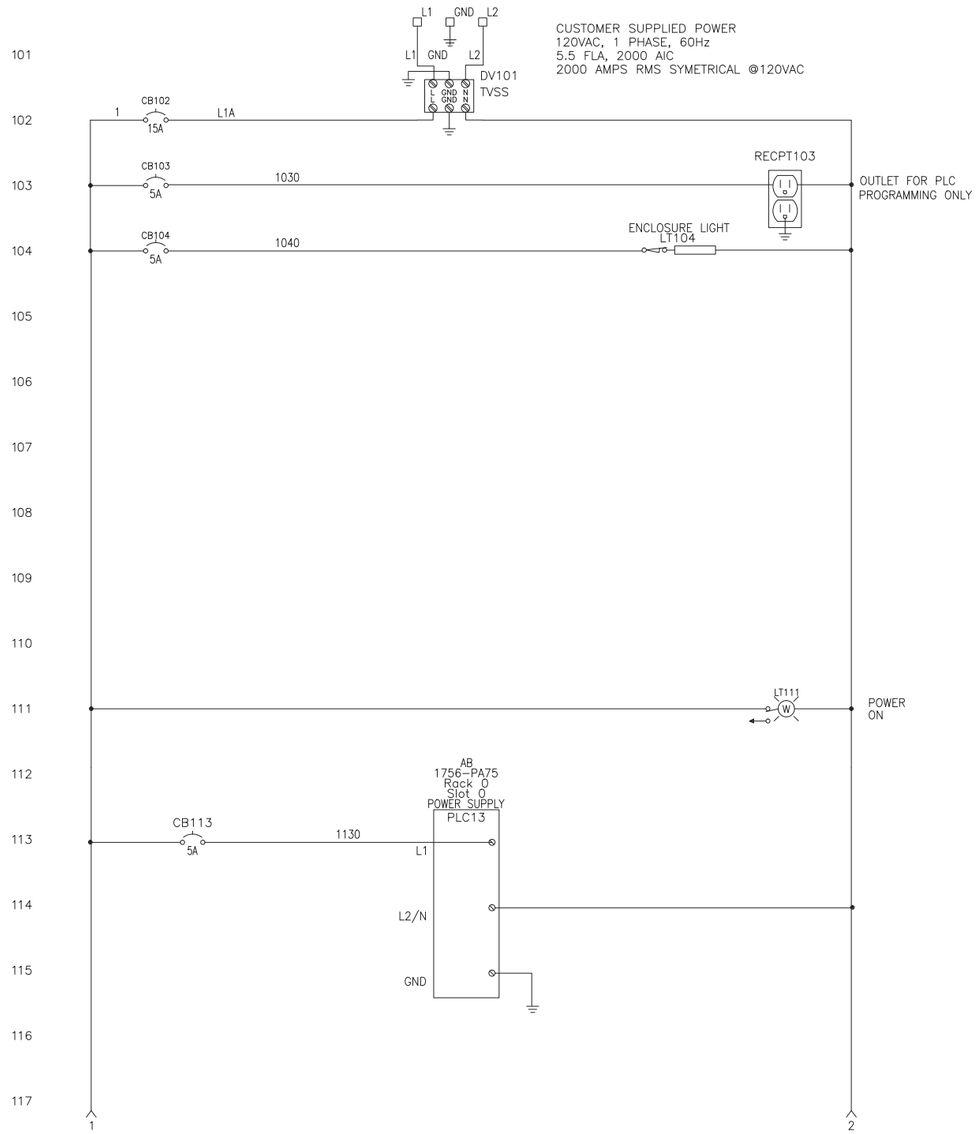
Communication is allowed.

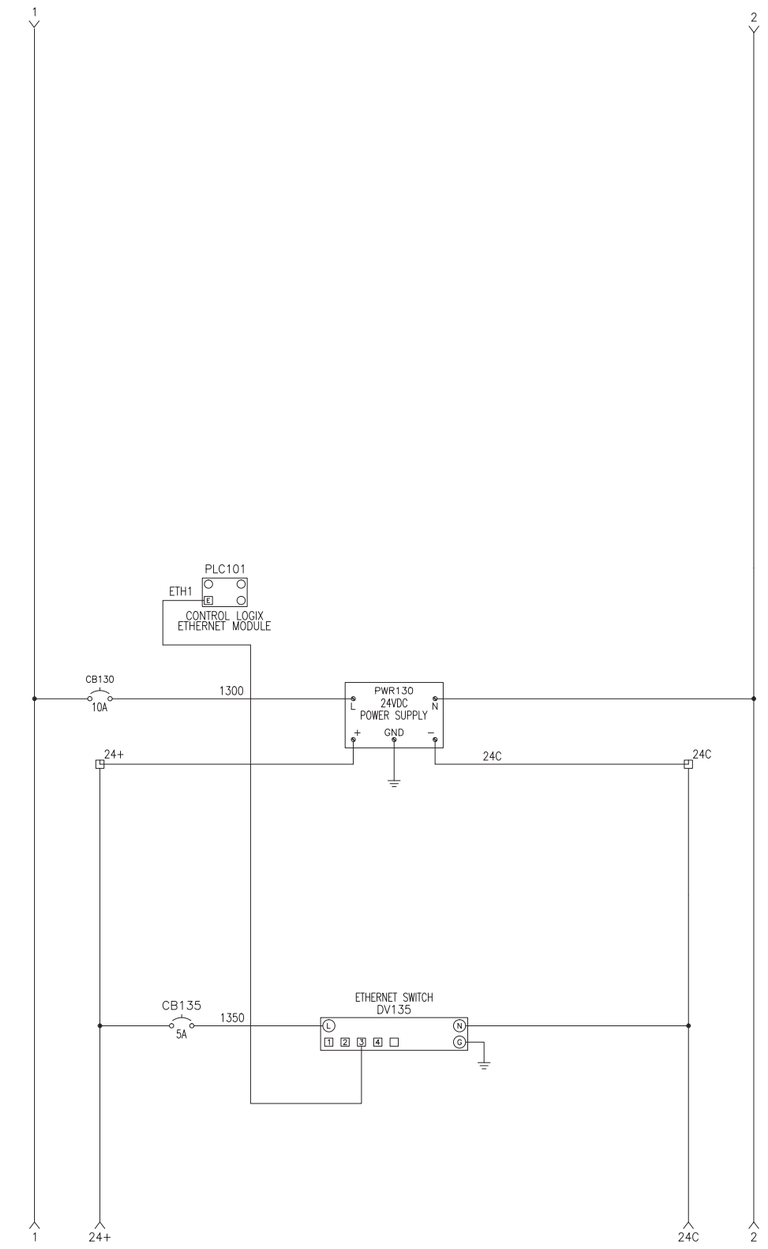


Physical Module
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16
Major Revision = 3
Minor Revision = 2



IMPORTANT Changing electronic keying selections online may cause the I/O communication connection to the module to be disrupted and may result in a loss of data.





NOTES: WIRING SPEC:
PLC CARD WIRING – #16AWG STRANDED MTW OR EQUAL, 300V @ 90°C, UNLESS OTHERWISE NOTED.
CONTROL WIRING – #14AWG STRANDED MTW OR EQUAL, 600V @ 90°C, UNLESS OTHERWISE NOTED.
POWER WIRING – #12AWG STRANDED MTW OR EQUAL, 600V @ 90°C, MINIMUM, SIZED FOR CIRCUIT CURRENT.
WIRE COLOR CODES:
BLACK – POWER WIRING (MULTI-PHASE) 230VAC OR GREATER, 120VAC UNSWITCHED CONTROL WIRING.
RED – 120VAC SWITCHED CONTROL WIRING.
WHITE – 120VAC NEUTRAL WIRING.
GREEN – GROUNDED CONDUCTORS.
BLUE – UNGROUNDED DC CONTROL WIRING.
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CUSTOMER CIRCUITS:
DRY CONTACTS ARE RATED FOR 6 AMPERES @ 120VAC. SUITABLE PROTECTION AND DISCONNECT MEANS ARE TO BE PROVIDED BY CUSTOMER. USE #14AWG MINIMUM.
ALL HOLES TO BE SEALED AND GASKETED TO MAINTAIN ENCLOSURE INTEGRITY.

WIRED IN SHOP PRIOR TO SHIPMENT
FIELD WIRING UNLESS OTHERWISE NOTED

STD: 1-0200-24X36D1 | INTL REF: | BAR = 1" AT PLOT SCALE

REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN
1	AS BUILTS	9/18/13	AJJ			
0	RELEASED	5/13/13	AJJ			
B	REMOVED ITEM 515, ADDED ITEM 452. ADDED SS AT LINE102.	3-27-13	AJJ			
A	REMOVED UPS. CHANGED PLC COMPONENTS. SWITCH, DI SS AND INDICATING LIGHT.	2/7/13	AJJ			

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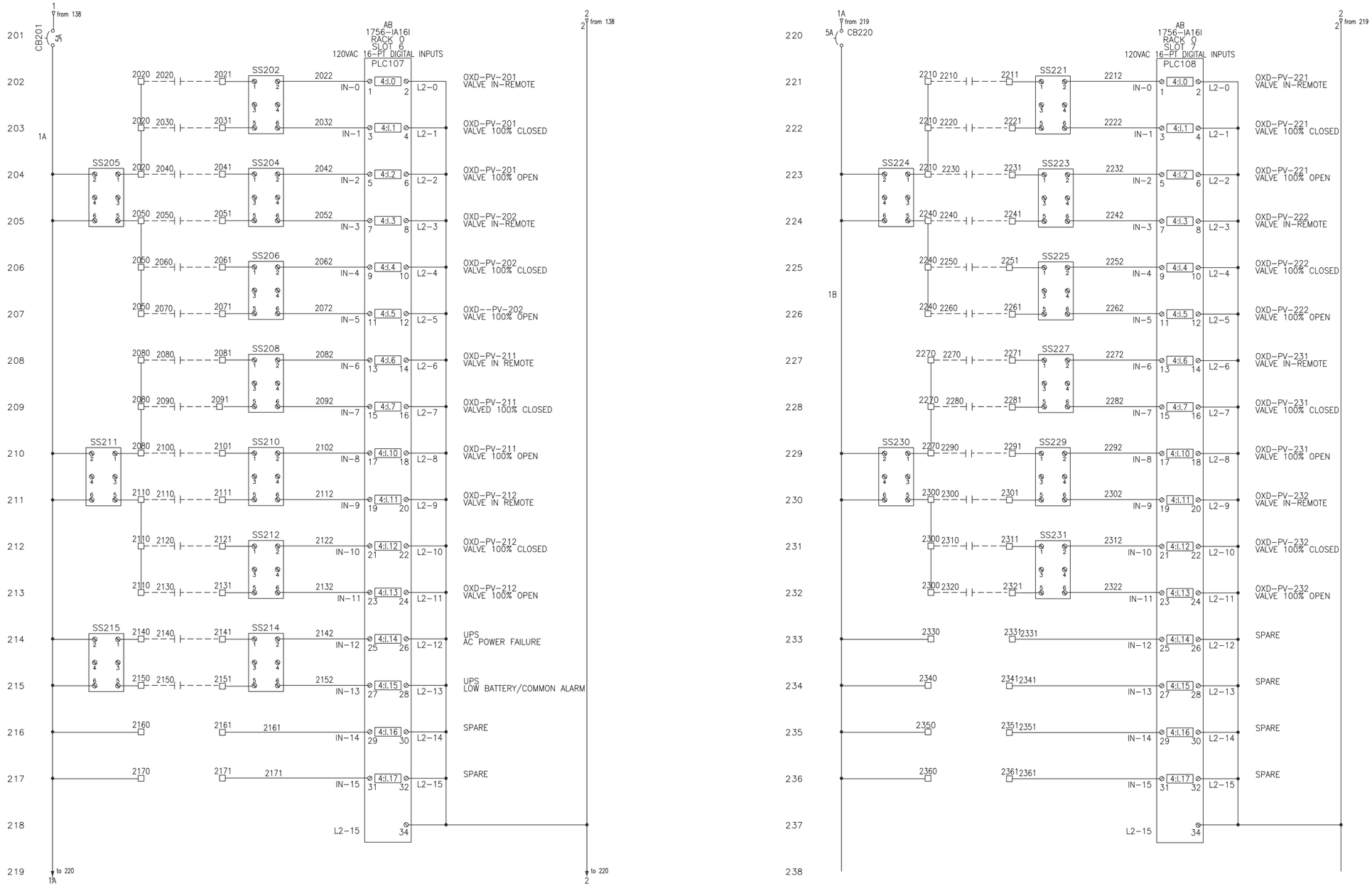
DESIGNER	AJJ
DATE	12/04/12
CHECKER	
DATE	
ENGINEER	
DATE	
MANAGER	
DATE	
MADE FROM:	
SCALE:	

TITLE: SMART BNR CONTROL SYSTEM
ELECTRICAL SCHEMATICS

CUST.: MAX FOOTE CONSTRUCTION CO.
LOC.: BOSSIER CITY, LA
ENG.:

EVOQUA WATER TECHNOLOGIES
Water Technologies
Waukesha, WI
262-547-0141

PROJECT	CODE	DRAWING	SHEET	REV
2033/000140	4034	44792-893-01	1 OF 1	1



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MADE FROM:	
SCALE:	

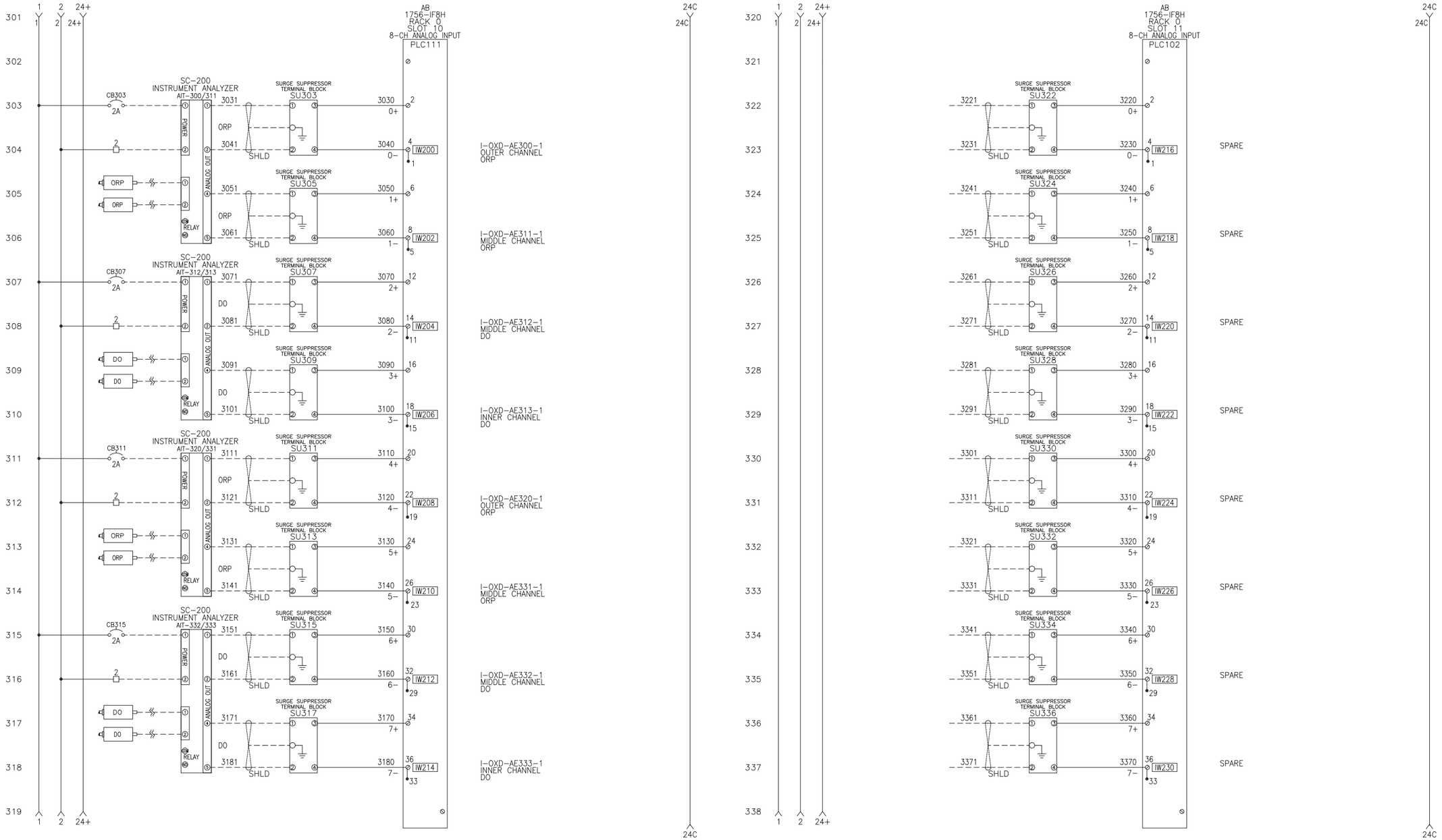
TITLE: SMART BNR CONTROL SYSTEM
ELECTRICAL SCHEMATICS–DIGITAL INPUTS

CUST.: MAX FOOTE CONSTRUCTION CO.
LOC.: BOSSIER CITY, LA
ENG.:

evoqua WATER TECHNOLOGIES
Water Technologies
Waukesha, WI
262-547-0141

PROJECT	CODE	DRAWING	SHEET	REV
2033/000140	4034	44792-893-02	1 OF 1	1

STD: 1-0200-24X36D1 | INTL REF: | BAR = 1" AT PLOT SCALE



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WIRED IN SHOP PRIOR TO SHIPMENT

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MANAGER	
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SCALE:	

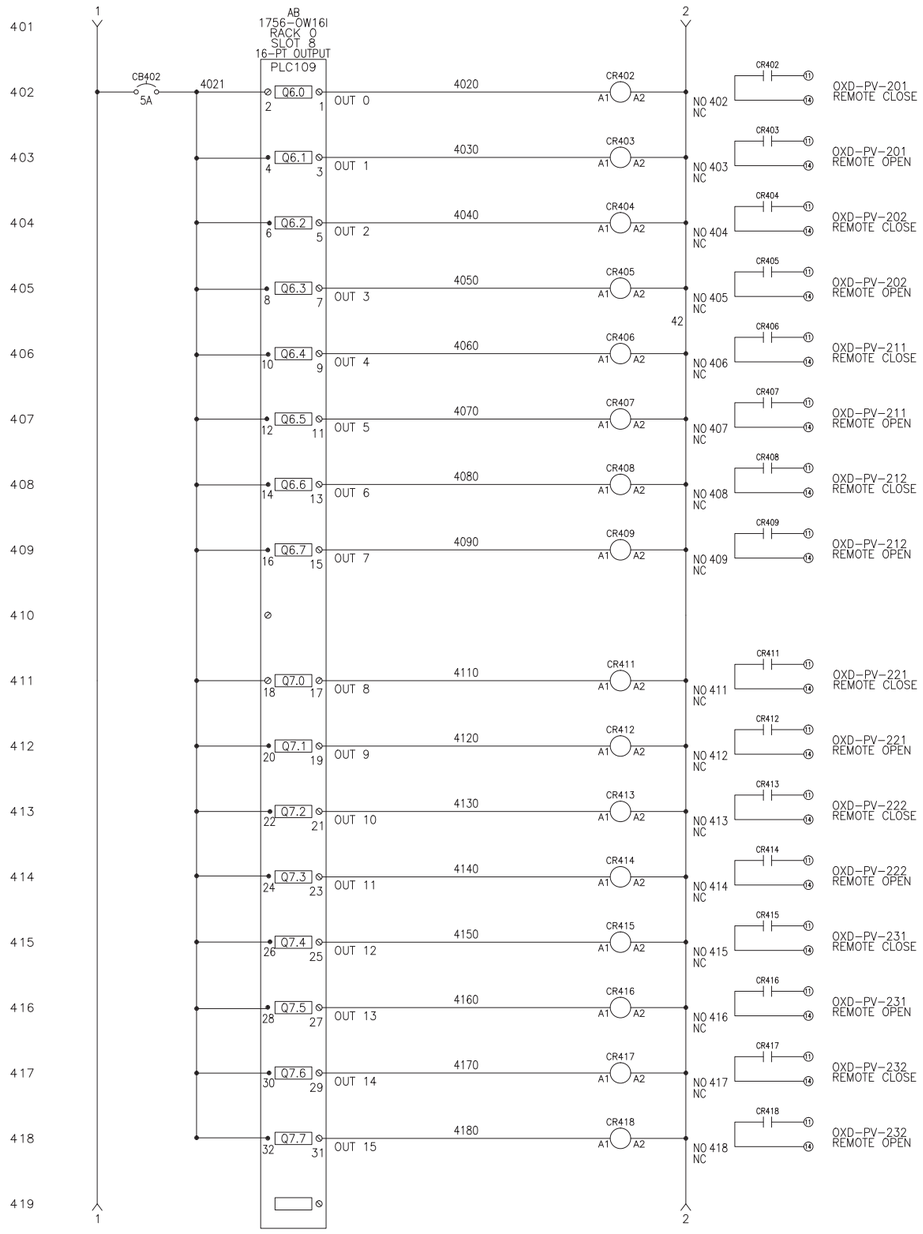
TITLE: SMART BNR CONTROL SYSTEM
ELECTRICAL SCHEMATICS–ANALOG INPUTS

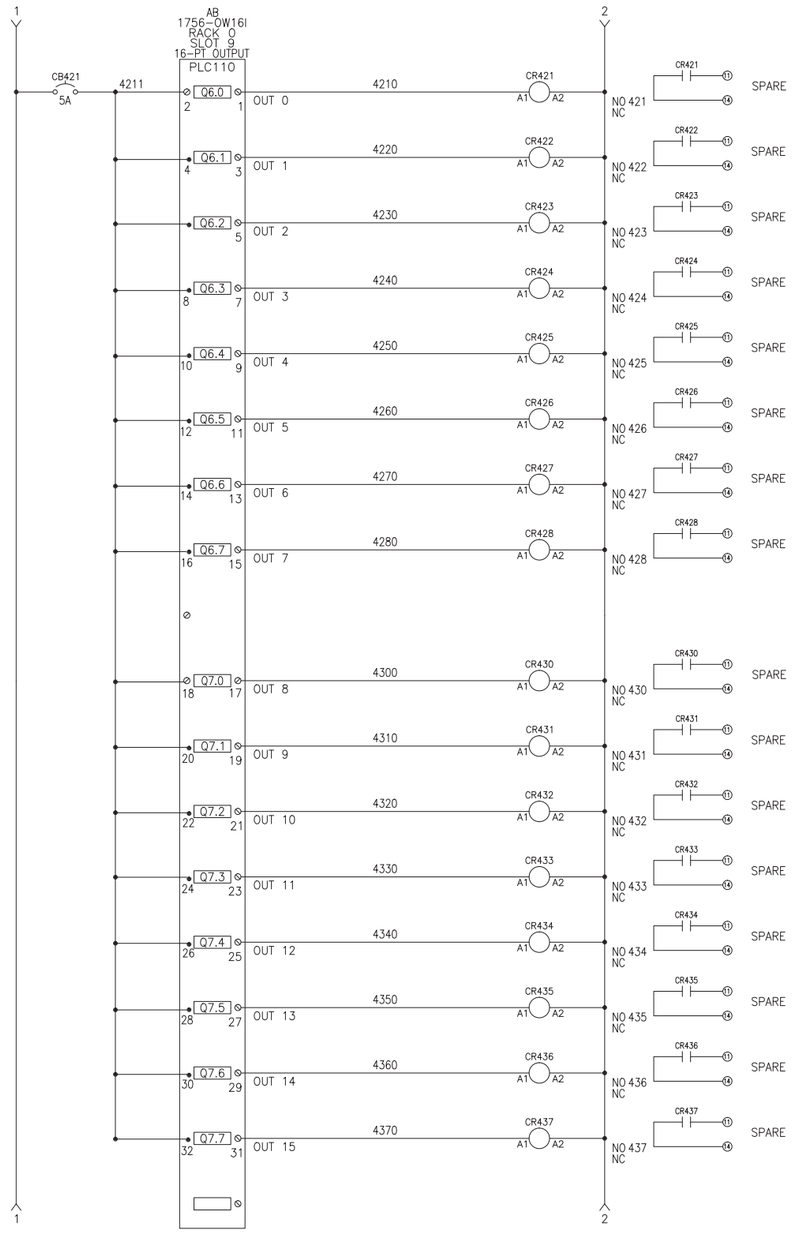
CUST.: MAX FOOTE CONSTRUCTION CO.
LOC.: BOSSIER CITY, LA
ENG.:

EVOQUA WATER TECHNOLOGIES
Water Technologies
Waukesha, WI
262-547-0141

PROJECT	CODE	DRAWING	SHEET	REV
2033/000140	4034	44792-893-03	1 OF 1	1

STD: 1-0200-24X36D1 | INTL REF: | BAR = 1" AT PLOT SCALE





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BAR = 1" AT PLOT SCALE

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SCALE:	

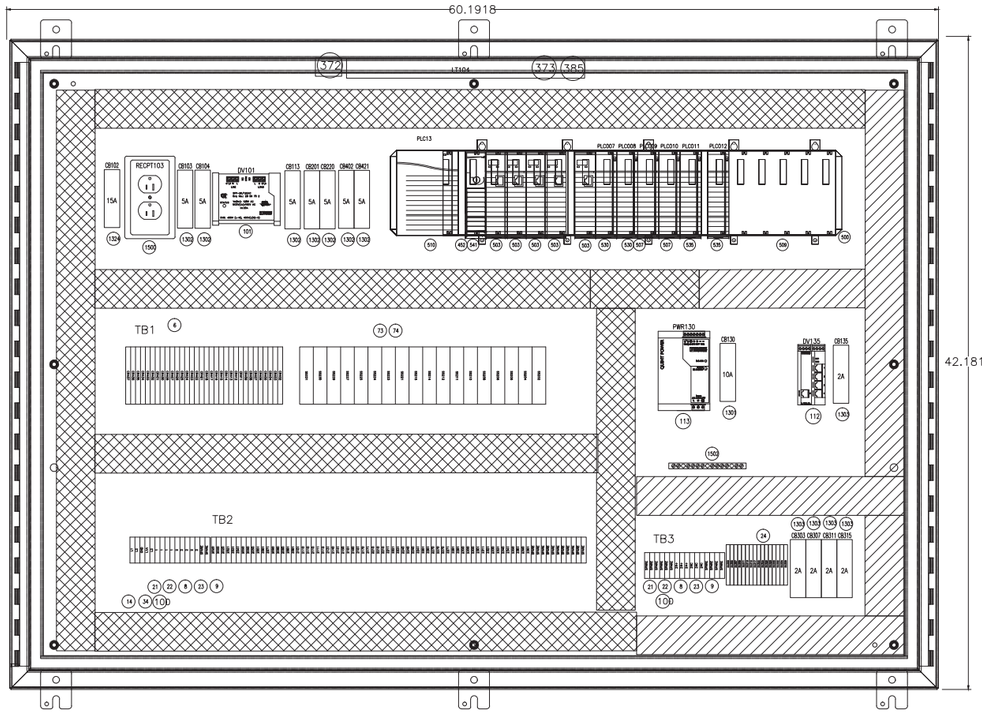
TITLE: SMART BNR CONTROL SYSTEM
ELECTRICAL SCHEMATICS–DIGITAL OUTPUTS

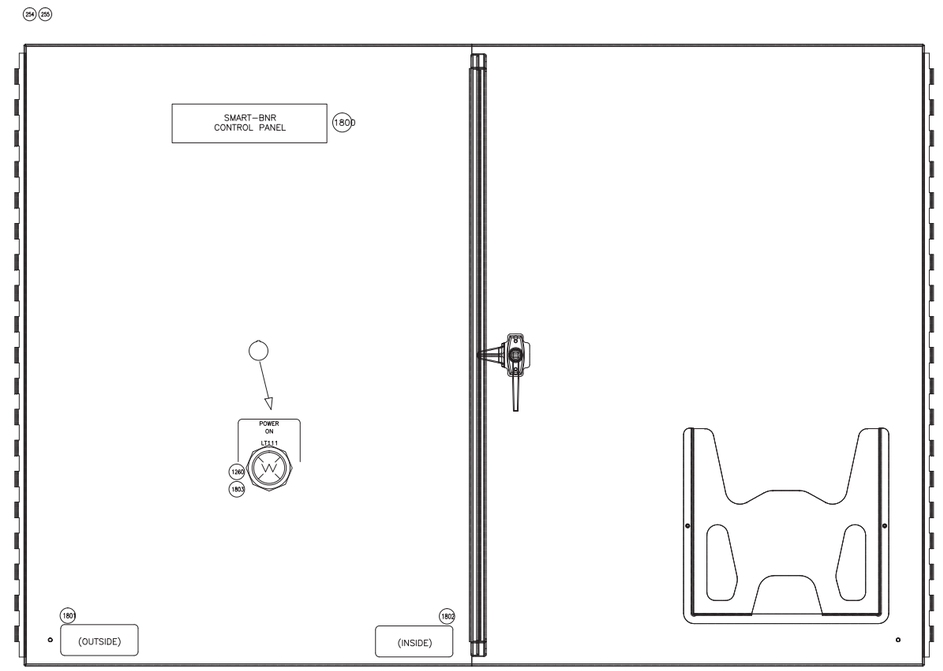
CUST.: MAX FOOTE CONSTRUCTION CO.
LOC.: BOSSIER CITY, LA
ENG.:

EVOQUA WATER TECHNOLOGIES
Water Technologies
Waukesha, WI
262-547-0141

PROJECT	CODE	DRAWING	SHEET	REV
2033/000140	4034	44792-893-04	1 OF 1	1

STD: 1-0200-24X36D1 | INTL REF:





LABEL ITEM 1801 DETAIL:

SIEMENS
Automated Controls
Siemens Industry, Inc.
Waukesha, WI
262-547-0141 or 800-524-6324

NOTES:
SEE DRAWINGS 44792–893–01 THROUGH –11 FOR ELECTRICAL SCHEMATICS

ITEM 1802 TO BE LABELED WITH THE FOLLOWING:
SERIAL NO. 44792–893–05
LINE VOLTS: 120 V, 1 PH., 60 HZ
LINE AMPS: 5.5 FLA
CONTROL VOLTS: 120 V, 1 PH., 60 HZ
CONTROL AMPS: 5.5 FLA
LARGEST MOTOR FLA: N/A
SHORT CIRCUIT CURRENT:
RMS SYMMETRICAL, 120 V MAXIMUM

NOTES: WIRING SPEC:
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WIRED IN SHOP PRIOR TO SHIPMENT
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DATE	12/04/12
CHECKER	
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ENGINEER	
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MANAGER	
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MADE:	
FROM:	
SCALE:	

TITLE: SMART BNR CONTROL SYSTEM PANEL LAYOUT
CUST.: MAX FOOTE CONSTRUCTION CO.
LOC.: BOSSIER CITY, LA
ENG.:

EVOQUA WATER TECHNOLOGIES
Water Technologies
Waukesha, WI
262–547–0141

PROJECT	CODE	DRAWING	SHEET	REV
2033/000140	4034	44792–893–05	1 OF 1	1

STD: 1–0200–24X36D1 | INTL REF:

BAR = 1" AT PLOT SCALE

TB1
120V (DO CR AND DI SS)

CR402
CR403
CR404
CR405
CR406
CR407
CR408
CR409
CR411
CR412
CR413
CR414
CR415
CR416
CR417
CR418
CR421
CR422
CR423
CR424
CR425
CR426
CR427
CR428
CR430
CR431
CR432
CR433
CR434
CR435
CR436
CR437

SS202
SS204
SS205
SS206
SS208
SS210
SS211
SS212
SS214
SS215
SS221
SS223
SS224
SS225
SS227
SS229
SS230
SS231

TB2
120V

2020
2020
2020
2021
2031
2041
2050
2050
2050
2051
2061
2071
2080
2080
2080
2081
2091
2101
2110
2110
2110
2111
2121
2131
2140
2141
2150
2151
2160
2161
2170
2171
2210
2210
2210
2211
2221
2231
2240
2240
2240
2240
2241
2251
2261
2270
2270
2270
2271
2281
2291
2300
2300
2300
2301
2311
2321
2330
2331
2340
2341
2350
2351
2360
2361
SPARE
SPARE
SPARE
SPARE
SPARE
SPARE
SPARE
SPARE
SPARE
SPARE
SPARE
SPARE

L1
L2
GND
SPARE
SPARE
1
1
1
1
2
2
2
2
SPARE
SPARE

TB3
24V (AI SS)

SPARE
SPARE
SPARE
SPARE
SPARE
SPARE
24+
24+
24+
24C
24C
24C
SPARE
SPARE
SPARE
SPARE

SU303
SU305
SU307
SU309
SU311
SU313
SU315
SU317
SU322
SU324
SU326
SU328
SU330
SU332
SU334
SU336

2A	CB303
2A	CB307
2A	CB311
2A	CB315

LIST OF MATERIAL FOR ONE (1) W3T269315 SMART-BNR CONTROL PANEL				
ITEM#	QTY	CATALOG	DESC	MFG
6	32	2966197	MINI RELAY TERMINAL BLOCK, 120VAC COIL	PHOENIX CONTACT
8	6	800886	END ANCHOR	PHOENIX CONTACT
9	12	1201099	ANGLED BRACKET	PHOENIX CONTACT
14	1	442079	GROUND TERMINAL BLOCK	PHOENIX CONTACT
21	105	3044131	UNIVERSAL TERMINAL BLOCK – UT 6 (GRAY)	PHOENIX CONTACT
22	3	3047028	END BARRIER – UT 6 (GRAY)	PHOENIX CONTACT
23	2	3030310	TERMINAL JUMPER 5P 600V – UT 6	PHOENIX CONTACT
24	16	2838186	DC SIGNAL SURGE SUPPRESSOR	PHOENIX CONTACT
34	4	3118135	TERMINAL JUMPER 10P 600V FOR 3007204	PHOENIX CONTACT
72	6	1201413	END ANCHOR TYPE E/UK 1	PHOENIX CONTACT
73	18	2839185	SURGE PROTECTION CONNECTOR	PHOENIX CONTACT
74	18	2839282	TYPE 3 SURGE PROTECTION BASE ELEMENT	PHOENIX CONTACT
100	3	0801733	DIN MOUNTING RAIL 2 M LENGTH	PHOENIX CONTACT
101	1	2856702	TRABTECH SURGE SUPPRESSOR	PHOENIX CONTACT
112	1	EDS-405A-EIP-T	5 PORT MANAGED ETHERNET SWITCH (WIDE TEMPERATURE)	MOXA
113	1	2866763	QUINT 24 VDC POWER SUPPLY, 10 AMP	PHOENIX CONTACT
254	1	A426012WFALP	TYPE 12 42"x60"x12" WALL-MOUNT ENCLOSURE	HOFFMAN
255	1	A60BFP42	SUBPANEL	HOFFMAN
372	1	ALFSWD	FLUORESCENT LIGHT DOOR SWITCH	HOFFMAN
373	1	LF120V18	FLUORESCENT LIGHT	HOFFMAN
385	1	LDSWITCH	FLUORSCENT LIGHT DOOR SWITCH CABLE	HOFFMAN
452	1	1784-SD1	1GB SD MEMORY CARD FOR PROCESSOR	ALLEN-BRADLEY
500	1	1756-A17	CONTROL LOGIX 17-SLOT CHASSIS	ALLEN-BRADLEY
503	5	1756-ENBT	CONTROL LOGIX ETHERNET CARD	ALLEN-BRADLEY
507	2	1756-OW16I	CONTROL LOGIX 16 POINT RELAY OUTPUT CARD	ALLEN-BRADLEY
509	5	1756-N2	CONTROL LOGIX SLOT FILLER	ALLEN-BRADLEY
510	1	1756-PA75	CONTROL LOGIX POWER SUPPLY	ALLEN-BRADLEY
527	6	1756-TBCH	CONTROL LOGIX TERMINAL BLOCK 36 PIN SCREW	ALLEN-BRADLEY
528	6	1756-TBE	CONTROL LOGIX TERMINAL BLOCK EXTENDED HOUSING	ALLEN-BRADLEY
530	2	1756-IA16I	CONTROL LOGIX 16 POINT ISOLATED DIGITAL INPUT CARD	ALLEN-BRADLEY
535	2	1756-IF8H	CONTROL LOGIX 8-POINT HART ANALOG INPUT CARD	ALLEN-BRADLEY
541	1	1756-L72	CONTROL LOGIX PROCESSOR, 4MB RAM	ALLEN-BRADLEY
1260	1	52BT6GBAB	WHITE PILOT LIGHT-PRESS TO TEST-NEMA 4X, 6V LED	SIEMENS
1301	1	5SJ41107HG40	BRANCH CIRCUIT BREAKER, 10 AMP	SIEMENS
1302	7	5SJ41117HG40	SUPPLEMENTARY CIRCUIT BREAKER – 5A	SIEMENS
1303	5	5SJ41027HG40	SUPPLEMENTARY CIRCUIT BREAKER – 2A	SIEMENS
1324	1	BQ1B0150LD	CIRCUIT BREAKER TYPE BQ – 125A FRAME – 15A	SIEMENS
1500	1	DRUBGFI15	DUPLEX GFCI RECEPTACLE	HUBBELL
1502	1	PK12GTA	GROUND BUS BAR	SQD
1691	1	375-M-00004-VC6-1	RUST/CORROSION INHIBITOR, 6FT RADIUS	ZERUST
1800	1	LAMICOID	LEGEND	PANEL SHOP
1801	1	W2T438450	DATA LABELS – KIT	PANEL SHOP
1802	1	W2T438453	SERIAL # / DATA LABEL	PANEL SHOP
1803	1	LAMICOID	LEGEND #FS400	PANEL SHOP
1804	24FT	WIREWAY	WIREWAY 2.5"X3" WHITE/COVER	PANEL SHOP
1806	2	CAT-5E CABLE, 6FT	CAT5 ETHERNET CABLE	PANEL SHOP
1833	1	1629B	MULTIPLE POWER SOURCE	SETON OR EQUAL

NOTES: WIRING SPEC:
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- CONTROL WIRING – #14AWG STRANDED MTW OR EQUAL, 600V @ 90°C, UNLESS OTHERWISE NOTED.
- POWER WIRING – #12AWG STRANDED MTW OR EQUAL, 600V @ 90°C, MINIMUM, SIZED FOR CIRCUIT CURRENT.

WIRE COLOR CODES:
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- GREEN – GROUNDED CONDUCTORS.
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- YELLOW – EXTERNALLY POWERED CIRCUITS (CUSTOMER CONTACTS).

CUSTOMER CIRCUITS:
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- ALL HOLES TO BE SEALED AND GASKETED TO MAINTAIN ENCLOSURE INTEGRITY.

STD: 1-0200-24X36D1 | INTL REF:

WIRED IN SHOP PRIOR TO SHIPMENT
FIELD WIRING UNLESS OTHERWISE NOTED

BAR = 1" AT PLOT SCALE

REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN
1	AS BUILTS	9/18/13	AJJ			
0	RELEASED	5/13/13	AJJ			
B	REMOVED ITEM 515, ADDED ITEM 452. ADDED SS AT LINE102.	3-27-13	AJJ			
A	REMOVED UPS, CHANGED PLC COMPONENTS. SWITCH, DI SS AND INDICATING LIGHT.	2/7/13	AJJ			

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DESIGNER	AJJ	DATE 12/04/12
CHECKER		DATE
ENGINEER		DATE
MANAGER		DATE
MADE FROM:		
SCALE:		

TITLE: SMART BNR CONTROL SYSTEM
TERMINAL LAYOUT AND BILL OF MATERIALS

CUST.: MAX FOOTE CONSTRUCTION CO.
LOC.: BOSSIER CITY, LA
ENG.:

evoqua WATER TECHNOLOGIES
Water Technologies
Waukesha, WI
262-547-0141

PROJECT	CODE	DRAWING	SHEET	REV
2033/000140	4034	44792-893-06	1 OF 1	1

WIRE INTERCONNECT LIST (DIGITAL INPUTS AND OUTPUTS)

SH	REF	TERMINAL	WIRENO 1	WIRE NO 2	TERMINAL	DESCRIPTION			SH	REF	RELAY	WIRE 1	DESCRIPTION
2	02	2020	2020	2021	2021	OXD-PV-201			4	402	CR402	4020	OXD-PV-201
2	03	2020	2030	2031	2031	OXD-PV-201			4	403	CR403	4030	OXD-PV-201
2	04	2020	2040	2041	2041	OXD-PV-201			4	404	CR404	4040	OXD-PV-202
2	05	2050	2050	2051	2051	OXD-PV-202			4	405	CR405	4050	OXD-PV-202
2	06	2050	2060	2061	2061	OXD-PV-202			4	406	CR406	4060	OXD-PV-211
2	07	2050	2070	2071	2071	OXD-PV-202			4	407	CR407	4070	OXD-PV-211
2	08	2080	2080	2081	2081	OXD-PV-211			4	408	CR408	4080	OXD-PV-212
2	09	2080	2090	2091	2091	OXD-PV-211			4	409	CR409	4090	OXD-PV-212
2	10	2080	2100	2101	2101	OXD-PV-211			4	411	CR411	4110	OXD-PV-221
2	11	2110	2110	2111	2111	OXD-PV-212			4	412	CR412	4120	OXD-PV-221
2	12	2110	2120	2121	2121	OXD-PV-212			4	413	CR413	4130	OXD-PV-222
2	13	2110	2130	2131	2131	OXD-PV-212			4	414	CR414	4140	OXD-PV-222
2	14	2140	2140	2141	2141	UPS POW FAIL			4	415	CR415	4150	OXD-PV-231
2	15	2150	2150	2151	2151	UPS LOW BATT			4	416	CR416	4160	OXD-PV-231
2	16	2160			2161	SPARE			4	417	CR417	4170	OXD-PV-232
2	17	2170			2171	SPARE			4	418	CR418	4180	OXD-PV-232
2	21	2210	2210	2211	2211	OXD-PV-221			4	421	CR421	4210	SPARE
2	22	2210	2220	2221	2221	OXD-PV-221			4	422	CR422	4220	SPARE
2	23	2210	2230	2231	2231	OXD-PV-221			4	423	CR423	4230	SPARE
2	24	2240	2240	2241	2241	OXD-PV-222			4	424	CR424	4240	SPARE
2	25	2240	2250	2251	2251	OXD-PV-222			4	425	CR425	4250	SPARE
2	26	2240	2260	2261	2261	OXD-PV-222			4	426	CR426	4260	SPARE
2	27	2270	2270	2271	2271	OXD-PV-231			4	427	CR427	4270	SPARE
2	28	2270	2280	2281	2281	OXD-PV-231			4	428	CR428	4280	SPARE
2	29	2270	2290	2291	2291	OXD-PV-231			4	430	CR430	4300	SPARE
2	30	2300	2300	2301	2301	OXD-PV-232			4	431	CR431	4310	SPARE
2	31	2300	2310	2311	2311	OXD-PV-232			4	432	CR432	4320	SPARE
2	32	2300	2320	2321	2321	OXD-PV-232			4	433	CR433	4330	SPARE
2	33	2330			2331	SPARE			4	434	CR434	4340	SPARE
2	34	2340			2341	SPARE			4	435	CR435	4350	SPARE
2	35	2350			2351	SPARE			4	436	CR436	4360	SPARE
2	36	2360			2361	SPARE			4	437	CR437	4370	SPARE

NOTES: WIRING SPEC:
PLC CARD WIRING – #16AWG STRANDED MTW OR EQUAL, 300V @ 90°C, UNLESS OTHERWISE NOTED.
CONTROL WIRING – #14AWG STRANDED MTW OR EQUAL, 600V @ 90°C, UNLESS OTHERWISE NOTED.
POWER WIRING – #12AWG STRANDED MTW OR EQUAL, 600V @ 90°C, MINIMUM, SIZED FOR CIRCUIT CURRENT.
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RED – 120VAC SWITCHED CONTROL WIRING.
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ALL HOLES TO BE SEALED AND GASKETED TO MAINTAIN ENCLOSURE INTEGRITY.

WIRED IN SHOP PRIOR TO SHIPMENT

FIELD WIRING UNLESS OTHERWISE NOTED

REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN
1	AS BUILTS	9/18/13	AJJ			
0	RELEASED	5/13/13	AJJ			
B	REMOVED ITEM 515, ADDED ITEM 452. ADDED SS AT LINE102.	3-27-13	AJJ			
A	REMOVED UPS, CHANGED PLC COMPONENTS. SWITCH, DI SS AND INDICATING LIGHT.	2/7/13	AJJ			

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		DATE
DESIGNER	AJJ	12/04/12
CHECKER		DATE
ENGINEER		DATE
MANAGER		DATE
MADE FROM:		
SCALE:		

TITLE: SMART BNR CONTROL SYSTEM
DIGITAL I/O WIRE INTERCONNECT LIST

CUST.: MAX FOOTE CONSTRUCTION CO.
LOC.: BOSSIER CITY, LA
ENG.:

evoqua WATER TECHNOLOGIES
Water Technologies
Waukesha, WI
262-547-0141

PROJECT	CODE	DRAWING	SHEET	REV
2033/000140	4034	44792-893-07	1 OF 1	1

STD: 1-0200-24X36D1 | INTL REF:

BAR = 1" AT PLOT SCALE

WIRE INTERCONNECT LIST (ANALOG INPUTS)									
SH	REF	TERMINAL	WIRENO 1	WIRENO 2	TERMINAL	WIRENO 3	WIRENO 4	DESCRIPTION	
3	03	GTRM303	3030	3040	SU303	3031	3041	OXIDATION DITCH 1 OUTER CHANNEL ORP	I-OXD-AE300-1
3	05	GTRM305	3050	3060	SU305	3051	3061	OXIDATION DITCH 1 MIDDLE CHANNEL ORP	I-OXD-AE311-1
3	07	GTRM307	3070	3080	SU307	3071	3081	OXIDATION DITCH 1 MIDDLE CHANNEL DO	I-OXD-AE312-1
3	09	GTRM309	3090	3100	SU309	3091	3101	OXIDATION DITCH 1 INNER CHANNEL DO	I-OXD-AE313-1
3	11	GTRM311	3110	3120	SU311	3111	3121	OXIDATION DITCH 2 OUTER CHANNEL ORP	I-OXD-AE320-1
3	13	GTRM313	3130	3140	SU313	3131	3141	OXIDATION DITCH 2 MIDDLE CHANNEL ORP	I-OXD-AE331-1
3	15	GTRM315	3150	3160	SU315	3151	3161	OXIDATION DITCH 2 MIDDLE CHANNEL DO	I-OXD-AE332-1
3	17	GTRM317	3170	3180	SU317	3171	3181	OXIDATION DITCH 2 INNER CHANNEL DO	I-OXD-AE333-1
3	22	GTRM322	3220	3230	SU322	3221	3231	SPARE	
3	24	GTRM324	3240	3250	SU324	3241	3251	SPARE	
3	26	GTRM326	3260	3270	SU326	3261	3271	SPARE	
3	28	GTRM328	3280	3290	SU328	3281	3281	SPARE	
3	30	GTRM330	3300	3310	SU330	3301	3311	SPARE	
3	32	GTRM332	3320	3330	SU332	3321	3331	SPARE	
3	34	GTRM334	3340	3350	SU334	3341	3351	SPARE	
3	36	GTRM3036	3360	3370	SU336	3361	3371	SPARE	

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WIRED IN SHOP PRIOR TO SHIPMENT

FIELD WIRING UNLESS OTHERWISE NOTED

REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN
1	AS BUILTS	9/18/13	AJJ			
0	RELEASED	5/13/13	AJJ			
B	REMOVED ITEM 515, ADDED ITEM 452. ADDED SS AT LINE102.	3-27-13	AJJ			
A	REMOVED UPS, CHANGED PLC COMPONENTS. SWITCH, DI SS AND INDICATING LIGHT.	2/7/13	AJJ			

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DESIGNER	AJJ	DATE 12/04/12
CHECKER		DATE
ENGINEER		DATE
MANAGER		DATE
MADE FROM:		
SCALE:		

TITLE: SMART BNR CONTROL SYSTEM
ANALOG I/O WIRE INTERCONNECT LIST

CUST.: MAX FOOTE CONSTRUCTION CO.
LOC.: BOSSIER CITY, LA
ENG.:

evoqua WATER TECHNOLOGIES
Water Technologies
Waukesha, WI
262-547-0141

PROJECT	CODE	DRAWING	SHEET	REV
2033/000140	4034	44792-893-08	1 OF 1	1

STD: 1-0200-24X36D1 | INTL REF:

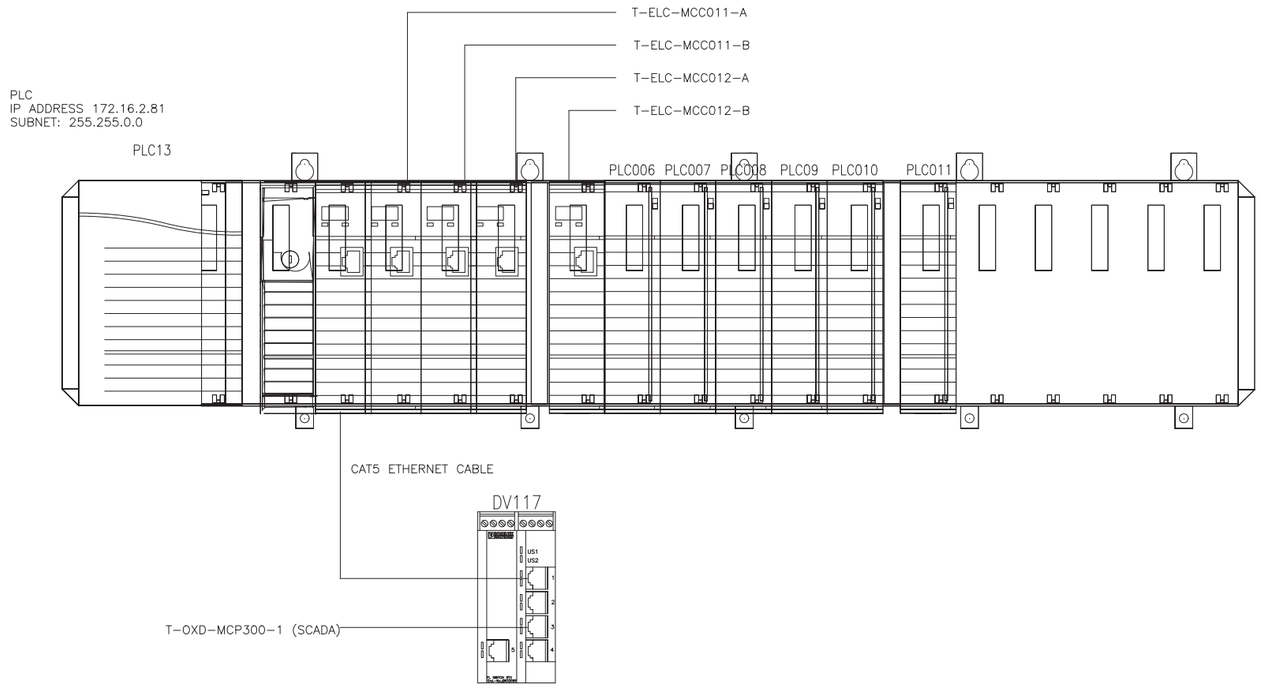
BAR = 1" AT PLOT SCALE

NETWORK CARD ELC-NSW-011A
IP ADDRESS 172.16.2.83
SUBNET: 255.255.0.0

NETWORK CARD ELC-NSW-011B
IP ADDRESS 172.16.2.84
SUBNET: 255.255.0.0

NETWORK CARD ELC-NSW-012A
IP ADDRESS 172.16.2.85
SUBNET: 255.255.0.0

NETWORK CARD ELC-NSW-012B
IP ADDRESS 172.16.2.86
SUBNET: 255.255.0.0



NETWORK SWITCH
IP ADDRESS 172.16.2.80
SUBNET: 255.255.0.0

NOTES: WIRING SPEC:
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FIELD WIRING UNLESS OTHERWISE NOTED

BAR = 1" AT PLOT SCALE

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DESIGNER	AJJ
DATE	12/04/12
CHECKER	
DATE	
ENGINEER	
DATE	
MANAGER	
DATE	
MADE FROM:	
SCALE:	

TITLE: SMART BNR CONTROL SYSTEM
NETWORK DIAGRAM

CUST.: MAX FOOTE CONSTRUCTION CO.
LOC.: BOSSIER CITY, LA
ENG.:

EVOQUA WATER TECHNOLOGIES
Water Technologies
Waukesha, WI
262-547-0141

PROJECT	CODE	DRAWING	SHEET	REV
2033/000140	4034	44792-893-09	1 OF 1	1

LIST OF MATERIALS FOR SMART BNR PROBES AND PROBE MOUNTING					
ITEM	QTY	W2T PART #s	CATALOG	DESC	MFG
1	4	W2T553647	90200-00	LDO PROBE	HACH
2	4	W2T500561	LXV404.99.00552	SC200 INSTRUMENT ANALYZER	HACH
3	4	W2T500592	9220600	SC200 SUN SHIELD	HACH
4	4	W2T333384	DRS5	ORP PROBE	HACH
5	2	W2T390376	25M2A1001-123	200 mV ORP TEST SOLUTION 1 GALLON	HACH
6	8	W2T409184	603-82091	DO/ORP HANDRAIL MOUNTING KITS	SIEMENS WT

NOTES:
SEE DRAWING 44792-893-11 FOR MOUNTING BRACKET ASSEMBLY DRAWING FOR HACH DO & ORP INSTRUMENTS

ALL PROBES MUST BE MOUNTED UP STREAM FROM THE DISC AERATORS TO PROVIDE ACCURATE READINGS. SEE DRAWING FOR SUGGESTED LOCATIONS.

NOTES: WIRING SPEC:
PLC CARD WIRING - #16AWG STRANDED MTW OR EQUAL, 300V @ 90°C, UNLESS OTHERWISE NOTED.
CONTROL WIRING - #14AWG STRANDED MTW OR EQUAL, 600V @ 90°C, UNLESS OTHERWISE NOTED.
POWER WIRING - #12AWG STRANDED MTW OR EQUAL, 600V @ 90°C, MINIMUM, SIZED FOR CIRCUIT CURRENT.
WIRE COLOR CODES:
BLACK - POWER WIRING (MULTI-PHASE) 230VAC OR GREATER, 120VAC UNSWITCHED CONTROL WIRING.
RED - 120VAC SWITCHED CONTROL WIRING.
WHITE - 120VAC NEUTRAL WIRING.
GREEN - GROUNDED CONDUCTORS.
BLUE - UNGROUNDED DC CONTROL WIRING.
WHITE W/BLUE STRIPE - GROUNDED DC CONTROL WIRING.
LIGHT BLUE - INTRINSICALLY SAFE WIRING.
YELLOW - EXTERNALLY POWERED CIRCUITS (CUSTOMER CONTACTS).
CUSTOMER CIRCUITS:
DRY CONTACTS ARE RATED FOR 6 AMPERES @ 120VAC. SUITABLE PROTECTION AND DISCONNECT MEANS ARE TO BE PROVIDED BY CUSTOMER. USE #14AWG MINIMUM.
ALL HOLES TO BE SEALED AND GASKETED TO MAINTAIN ENCLOSURE INTEGRITY.

STD: 1-0200-24X36D1 | INTL REF:

WIRED IN SHOP PRIOR TO SHIPMENT
FIELD WIRING UNLESS OTHERWISE NOTED

BAR = 1" AT PLOT SCALE

REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN
1	AS BUILTS	9/18/13	AJJ			
0	RELEASED	5/13/13	AJJ			
B	REMOVED ITEM 515, ADDED ITEM 452. ADDED SS AT LINE102.	3-27-13	AJJ			
A	REMOVED UPS, CHANGED PLC COMPONENTS. SWITCH, DI SS AND INDICATING LIGHT.	2/7/13	AJJ			

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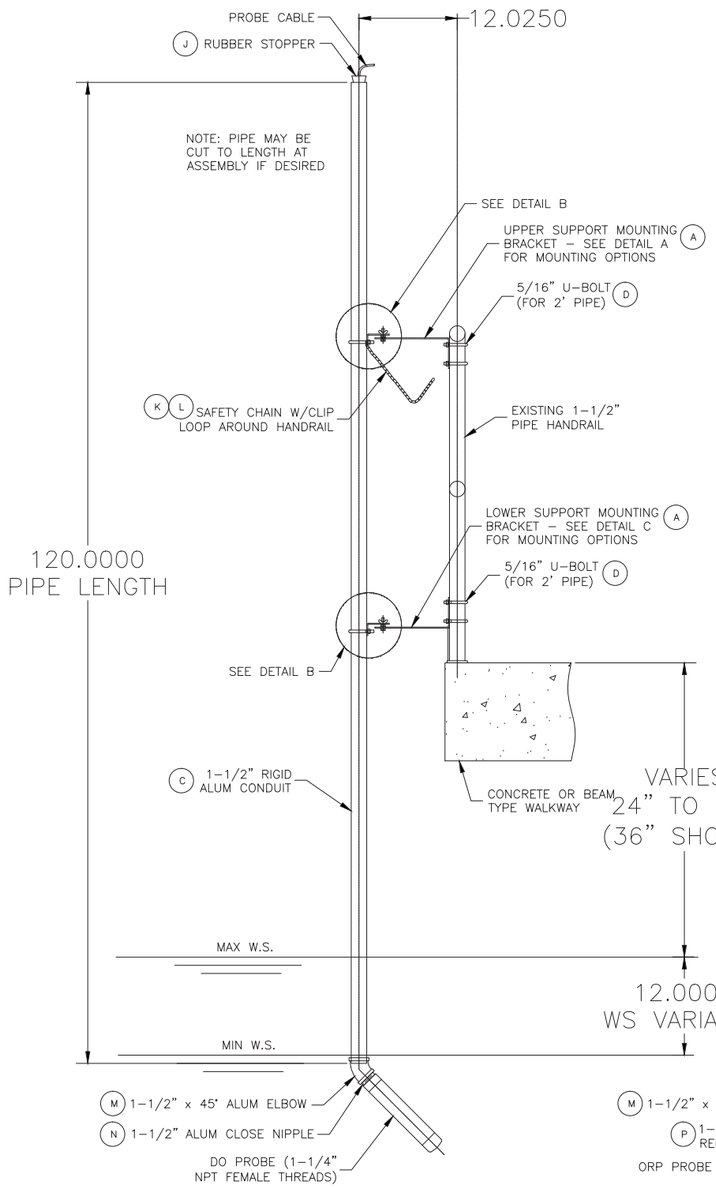
DESIGNER	AJJ	DATE 12/04/12
CHECKER		DATE
ENGINEER		DATE
MANAGER		DATE
MADE FROM:		
SCALE:		

TITLE: SMART BNR CONTROL SYSTEM
INSTRUMENT BILL OF MATERIALS

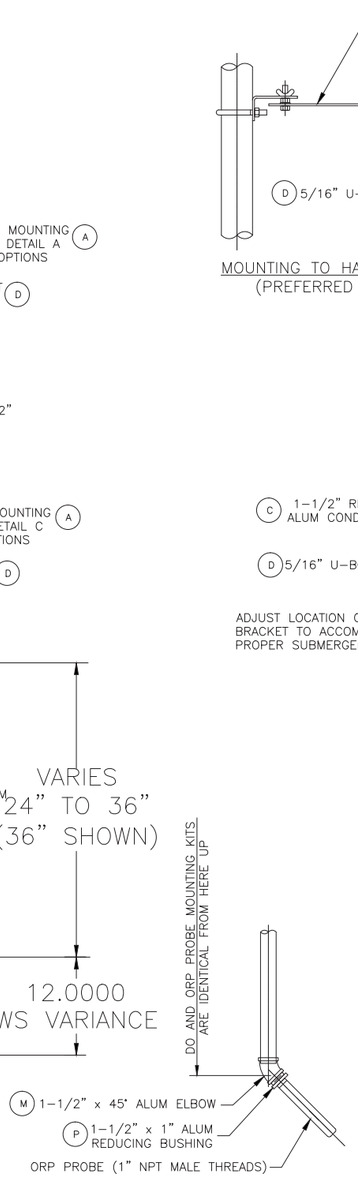
CUST.: MAX FOOTE CONSTRUCTION CO.
LOC.: BOSSIER CITY, LA
ENG.:

EVOQUA WATER TECHNOLOGIES
Water Technologies
Waukesha, WI
262-547-0141

PROJECT	CODE	DRAWING	SHEET	REV
2033/000140	4034	44792-893-10	1 OF 1	1

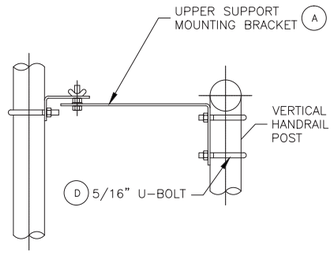

PROBE CABLE
12.0250
J RUBBER STOPPER
NOTE: PIPE MAY BE CUT TO LENGTH AT ASSEMBLY IF DESIRED
SEE DETAIL B
UPPER SUPPORT MOUNTING BRACKET – SEE DETAIL A FOR MOUNTING OPTIONS A
5/16" U-BOLT (FOR 2" PIPE) D
K L SAFETY CHAIN W/CLIP LOOP AROUND HANDRAIL
EXISTING 1-1/2" PIPE HANDRAIL
LOWER SUPPORT MOUNTING BRACKET – SEE DETAIL C FOR MOUNTING OPTIONS A
5/16" U-BOLT (FOR 2" PIPE) D
120.0000 PIPE LENGTH
SEE DETAIL B
C 1-1/2" RIGID ALUM CONDUIT
CONCRETE OR BEAM TYPE WALKWAY
VARIES 24" TO 36" (36" SHOWN)
MAX W.S.
12.0000 WS VARIANCE
MIN W.S.
M 1-1/2" x 45° ALUM ELBOW
N 1-1/2" ALUM CLOSE NIPPLE
DO PROBE (1-1/4" NPT FEMALE THREADS)

DO PROBE MOUNTING KIT

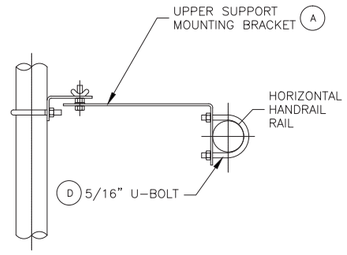

DO AND ORP PROBE MOUNTING KITS ARE IDENTICAL FROM HERE UP
M 1-1/2" x 45° ALUM ELBOW
P 1-1/2" x 1" ALUM REDUCING BUSHING
ORP PROBE (1" NPT MALE THREADS)

ORP PROBE MOUNTING KIT

NOTE: PROBES ARE PROVIDED SEPARATE FROM MOUNTING KITS

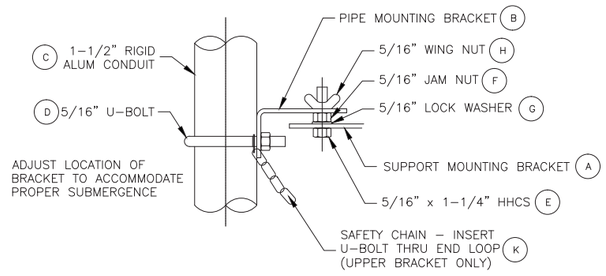


MOUNTING TO HANDRAIL POST
(PREFERRED METHOD)

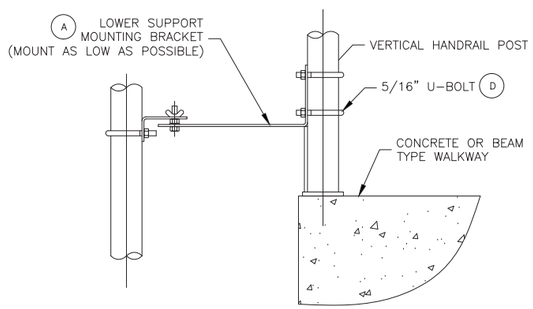


MOUNTING TO HORIZONTAL RAIL

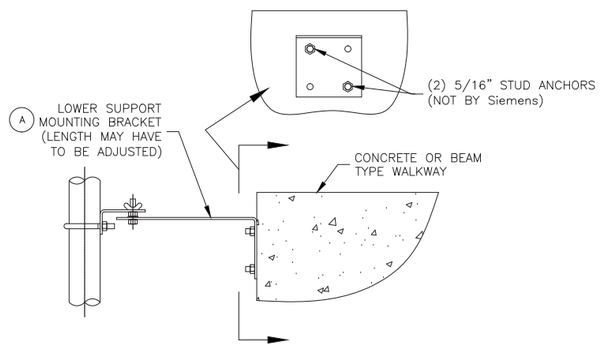
DETAIL A
(UPPER MOUNTING BRACKET OPTIONS)


PIPE MOUNTING BRACKET B
C 1-1/2" RIGID ALUM CONDUIT
5/16" WING NUT H
5/16" JAM NUT F
D 5/16" U-BOLT
5/16" LOCK WASHER G
SUPPORT MOUNTING BRACKET A
ADJUST LOCATION OF BRACKET TO ACCOMMODATE PROPER SUBMERGENCE
5/16" x 1-1/4" HHCS E
SAFETY CHAIN – INSERT U-BOLT THRU END LOOP (UPPER BRACKET ONLY) K

DETAIL B


A LOWER SUPPORT MOUNTING BRACKET (MOUNT AS LOW AS POSSIBLE)
VERTICAL HANDRAIL POST
5/16" U-BOLT D
CONCRETE OR BEAM TYPE WALKWAY

MOUNTING TO HANDRAIL POST
(PREFERRED METHOD)


(2) 5/16" STUD ANCHORS (NOT BY Siemens)
A LOWER SUPPORT MOUNTING BRACKET (LENGTH MAY HAVE TO BE ADJUSTED)
CONCRETE OR BEAM TYPE WALKWAY

MOUNTING TO CONCRETE WALKWAY

DETAIL C
(LOWER MOUNTING BRACKET OPTIONS)

MOUNTING NOTE: MOUNTING INFORMATION SHOWN IS PREFERRED ARRANGEMENT. IF HANDRAIL OR WALKWAY VARIES FROM AS SHOWN ADJUST MOUNTING ARRANGEMENT AS REQUIRED. KEEP LOWER MOUNTING BRACKET AS LOW AS POSSIBLE TO AVOID PIPE VIBRATION. IF EXTREME DEEP FREEBOARD EXISTS AN ADDITIONAL LOWER BRACKET MAY BE REQUIRED. COMPONENTS AS SHOWN AND LISTED ARE SUPPLIED BY Siemens Water Technologies IN A KIT FORM TO BE ASSEMBLED IN THE FIELD. ADDITIONAL COMPONENTS IF REQUIRED NOT SUPPLIED BY Siemens Water Technologies.

LIST OF COMPONENTS

ESTIMATED FINISHED WEIGHT:

DRAWING NUMBER: 703-1594

TITLE: GENERAL ARRANGEMENT PROBE MOUNTING SUPPORT

ALL LENGTHS ARE FINAL LENGTHS UNLESS OTHERWISE SPECIFIED

PROJECT NUMBER:

ADVANCE ORDER	REF. SYMBOL	QUANTITY	PART NUMBER	DESCRIPTION
	MATERIAL FOR ONE DO OR ORP PROBE MOUNTING KIT (W2T409184)			
	A	2		SUPPORT MOUNTING BRACKET 304SS
	B	2		PIPE MOUNTING BRACKET 304SS
	C	1		1-1/2" RIGID ALUM CONDUIT x 10'-0" LG
	D	6		5/16-18 304SS U-BOLT FOR 2" OD
	E	4		5/16 x 1.25 HHCS 304SS
	F	4		5/16 JAM NUT 304SS
	G	4		5/16 LOCK WASHER 304SS
	H	4		5/16 WING NUT 304SS
	J	1		RUBBER PLUG
	K	3ft		DOUBLE LOOP CHAIN
	L	1		SPRING SNAP
	M	1		1-1/2" x 45° ALUM THREADED ELBOW
	N	1		1-1/2" ALUM CLOSE NIPPLE
	P	1		1-1/2" MIPT TO 1" FIPT ALUM REDUCING BUSHING

NOTES: WIRING SPEC:
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- CONTROL WIRING – #14AWG STRANDED MTW OR EQUAL, 600V @ 90°C, UNLESS OTHERWISE NOTED.
- POWER WIRING – #12AWG STRANDED MTW OR EQUAL, 600V @ 90°C, MINIMUM, SIZED FOR CIRCUIT CURRENT.

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- RED – 120VAC SWITCHED CONTROL WIRING.
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STD: 1-0200-24X36D1 | INTL REF:

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FIELD WIRING UNLESS OTHERWISE NOTED

BAR = 1" AT PLOT SCALE

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DESIGNER: AJJ DATE: 12/04/12
CHECKER: DATE:
ENGINEER: DATE:
MANAGER: DATE:
MADE FROM:
SCALE:

TITLE: SMART BNR CONTROL SYSTEM INSTRUMENT MOUNTING DIAGRAM

CUST.: MAX FOOTE CONSTRUCTION CO.
LOC.: BOSSIER CITY, LA
ENG.:

EVOQUA WATER TECHNOLOGIES
Water Technologies
Waukesha, WI
262-547-0141

PROJECT	CODE	DRAWING	SHEET	REV
2033/000140	4034	44792-893-11	1 OF 1	1